Vol. XXV, No. 3
APRIL 1958

THE SCIENCE TEACHER

- Definitions, Didactics, and Deliberations
- Design for a Better Science Program
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- A Look at British Secondary Science Education
- STAR '58 Awards

JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION

Science speaks loud in space. The "beeps" of the satellites rival Emerson's "embattled farmers," whose shots were "heard round the world."

Science speaks louder in the kitchen, the hospital, the office, the factory, the classroom, and on the highways of land and air.

Students today need to hear and understand both the sound of the future and of the present. They need to know *how* the scientist works, *how* men set out to find answers, *how* men of science cooperate with each other to solve some of our problems.

But, you say, *all* students do not have comparable abilities to absorb. Some have never been made aware of how much science they *need* to live intelligently today. Others lack the conceptual knowledge and the vocabulary to understand.

True. This is our problem. *All* must know enough to respect the inquiring mind, support required research, apply the ways of science to their own problems. And *some* must make science their career.

To reach *all* means teaching in different ways. The group which moves ahead on its own needs one approach; the less independent, the slower paced need motivation and guidance. For the first group the learning materials must be piled high with content, challenge, and "plus" work; for the second group the materials must be accurate, complete, but less extensive, more illustrated, and less complex.

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THE SCIENCE TEACHER

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THE SCIENCE TEACHER

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- Rockets and Satellites in the IGY
- Separating Complex Substances by Chromatography
- Points and Counterpoint in Teaching Science
- The 1958 Science Achievement Awards for Students

THIS MONTH'S COVER is a photograph submitted with one of the winning entries in the 1958 STAR (Science Teacher Achievement Recognition) awards program. The entry, which won a $250 award, was submitted by Howard E. Norris of The Loomis School, Windsor, Connecticut. The title of the entry is "Planning and Operation of the Pre-College Science Center at The Loomis School." In this photograph Richard Sagebeer, left, a summer research assistant at United Aircraft Corporation, looks on while Richard Pollay of the Pre-College Science Center uses a subsonic model wind tunnel in working out a research problem.

Mr. Norris' entry was one of 58 cash award winners in the 1958 program. A list of these winners as well as a report on and evaluation of this year's STAR begins on page 146 of this issue of TST.

As was also the case with last year's STAR program, STAR '58 was conducted by the National Science Teachers Association under a grant from the National Cancer Institute of the U.S. Public Health Service. As originally announced last fall, plans for STAR '58, under a considerably expanded grant from NCI, called for $6750 in cash awards to 50 science teachers, including $50 awards to each of 35 teachers. However, because of the quality of the entries, the judges finally decided to increase the number of $50 awards to 43.

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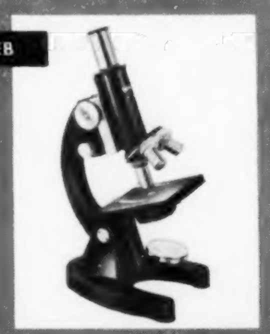

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Readers' Column

Herbert Zim gave some interesting facts and some challenging statements in his fine article, "Where is the Science in Science Education?" in the February issue of *TST*. But I wish to take issue with him on one of his statements: "Another look discloses an equal or greater amount of conservation education. It, too, is essential in these times—*but it is not science*." (Italics mine.)

It is a shock to me that one who showed such good reasoning and apparent scientific background in the rest of his article could show so little in this statement. Good conservation education includes background in botany, biology, and many other related fields. Surely Mr. Zim would not try to make us believe that conservation of wildlife, and all our natural resources, is not science!

Our teaching of science can only be of value to students as it helps them now and prepares them for the future. If we can teach them that the chemistry, physics, and biology they are now learning can be used to help them conserve that which is necessary to their welfare and livelihood, then we have achieved in science education.

I teach seventh- and eighth-grade science and biology. I intend sincerely to strive to teach my students to meet an increasingly complex technological world; but in doing so, I also intend to teach them to use their scientific knowledge to conserve the natural resources of their world which so much of our modern scientific advance may destroy.

J. L. PERSHALL
Lacrosse, Washington, Public Schools

The editorial, "Scrutiny, Castigation, and Constructive Support . . ." (December 1957 *TST*), is most opportune to our need. We do appreciate NSTA's endeavors on our behalf. And Dr. Glenn Blough's article, "Children, Put Away Your Sputniks" (December 1957 *TST*), is so timely and true!

ISABEL ROY
Durham, New Hampshire

I certainly wish to continue receiving the *Elementary School Science Bulletin*. Too bad a fund could not be established whereby it would be possible to send this little gem to every elementary school teacher in the nation.

HAROLD S. ANDERSON
Head of Education
Southern State Teachers College
Springfield, South Dakota

NSTA CALENDAR

April 20-24, 1958: 40th Annual Meeting, Scientific Apparatus Makers Association, Palm Springs, California

April 24-25, 1958: 1958 Eastern States Health Education Conference, New York Academy of Medicine, New York City

June 25-27, 1958: American Association of Physics Teachers, Boulder, Colorado

June 27-28, 1958: NSTA Annual Summer Meeting with the National Education Association, The Ohio State University, Columbus

June 29-July 4, 1958: National Education Association Annual Meeting, Cleveland, Ohio

September 7-12, 1958: 134th National Meeting, American Chemical Society, Chicago, Illinois

November 27-29, 1958: 58th Convention, Central Association of Science and Mathematics Teachers, Indianapolis, Indiana

Editor's Column

I have just lived through one of the most exciting—and rewarding—experiences of my professional life. I am talking about the just-finished 6th National Convention of NSTA at Denver. What I saw there, felt there, and absorbed there have renewed my deep conviction that despite the thousands of words being spoken and printed by real experts and self-appointed experts, the future security of United States science education lies mainly in one group—the classroom science teachers themselves.

The number of teachers—the total came to 1615—who registered at the Denver convention was a record for these NSTA annual meetings. Records are always something to be proud of and the committees which planned and managed the Denver convention certainly are justified in feeling proud. But much more important than the fact of a new record are the attitude, interest, and curiosity of the science teachers who attended the various Denver convention sessions.

It was plain that *they want to know*. They want to know more science and more up-to-date science. They want to know better ways of teaching science. They honestly want to find new and more effective means of developing the future scientists which they are certainly aware this nation needs so desperately.

They are underpaid (to many, their attendance at Denver was a real strain on their personal pocketbooks). They are not sure when—or how—they will be decently paid. But they are curious for knowledge; in fact, they are excited about how best to teach science in this suddenly distorted world which shoots up satellites and aims for the moon.

When you meet teachers like that—what can you say?

Would that every teacher who was at Denver could appear before a Congressional committee. I should like each one to testify about his or her problems as a science teacher, about how he meets them, about the excitement he gets from discovering a potential future scientist—and from aiding all young boys and girls. Perhaps their first-person reports would finally convince our legislators that the time for talk passed long ago; that the time for action is now.

On the way home from Denver, I had some chance to read. I read the *Life* (March 31) article about science teacher Donald Pearson, of Portland, Oregon. There are a multitude of Donald Pearsons among science teachers. Yet their enthusiasm and their dedication remain unquenched. If I had any doubts about this before, I cannot have them after Denver. These are the mainstays of the science teaching profession, which almost overnight has become distinguished and looked up to in the American social hierarchy. The challenge to these "little guys" is to keep that prestige for science; the challenge to the American public is to give them the recognition they have earned—materially, too, for man cannot live by dedication alone.

Robert H. Carleton

Definitions, Didactics, and Deliberations

By B. D. VAN EVERA

Dean for Sponsored Research, The George Washington University, Washington, D. C.

THE ultimate goal of education is to give the student, both at the high school level and in the college of liberal arts, a general understanding and appreciation of the world in which he lives. This means that the course of study must include something of science, of mathematics, of the background of the civilization of which he will become a part, of the economic conditions under which he will have to live, and of the theory and philosophy of the political atmosphere in which he will live.

The general courses of study to which our students are exposed cover a broad spectrum. The student must find out what fields of learning intrigue him, which he does not like, and which he likes well enough to spend his life in. The high school student therefore studies a considerable amount of sociology, history, literature, and some language, with a dip or two into science. Very often this science is purely descriptive, simply a collection of facts, and with that science I shall not deal here. Chemistry is one of the physical sciences, and while there is a great deal of descriptive matter available in it, by its nature it is capable of somewhat more precise study and experimentation than are some other fields of work.

A few reflections will make one realize that not all of the approaches to these fields of study are similar. The study of literature, for example, is far different from the study of history. The approaches to economics and chemistry are as far apart as the poles. This is not because economists are poorer scholars than chemists, or vice versa, but because of the nature of the areas in which they work.

This is brought out in the attempts to define the various concepts that are used. For example, in trying to define a word an economist will frequently spend several pages discussing the various aspects and uses of it, whereas to a chemist any definition which is more than one sentence long, and preferably a short sentence at that, is not a good definition. This is not because economists are more verbose than scientists, but it is because the material with which they work is not subject to the clear lines of demarcation that can be applied to the concepts used in physical sciences. Let me illustrate.

Is the world currently at peace or at war? Since 1939 the world has seen a terrific holocaust which stopped for a few years of what we all hoped was peace. This peace was interrupted by the Korean war followed by, as far as this country was concerned, a defense budget of prodigious size. This period has been referred to as an uneasy peace and as a cold war. Which is it? Any clear definition of war or peace in the sense in which a scientist defines an atom or a solution is almost impossible to make because of the very nature of things.

Again in the field of sociology, let us consider the concept of the word "family." Is a family the individuals related to each other who live under one roof? Are they a man and his wife and their descendants, which in these days of high mobility may mean that they are scattered literally to the ends of the earth? Two sisters living with their parents are certainly a part of the same family. If one of them marries and moves out and sets up her own home, is she still part of the original family despite the fact that she has started a family of her own? This is the sort of very difficult problem which people outside the sciences face when they try to define those ideas which are basic to their fields of learning.

The difference in the nature of these studies is reflected in the way in which one teaches them. In the social studies and humanities in general, the textbook is usually supplemented by extensive reading in the library. In chemistry and physics, however, especially in the elementary courses, extensive use of a library is not particularly frequent, the instruction usually being given from a single textbook supplemented by a proper laboratory manual and perhaps a problem book. When a

This article is based on a talk delivered June 24, 1957 at the University of Maryland Summer Conference on the Improvement of Science Teaching. The conference, which met on the College Park, Maryland campus from June 23 through July 6, was co-sponsored by the University of Maryland, the West Virginia Pulp and Paper Company, and the Future Scientists of America Foundation of the National Science Teachers Association.

chemistry student does go to the library to refer to other texts, the subjects he reads are usually more briefly written, and the articles in the journals are somewhat shorter than those in the social studies.

The physical sciences, then, are distinguished from the other fields of learning by the fact that we are able to define our concepts a great deal more rigidly. Indeed, for a scientist to do good work he must be possessed of a clear understanding of the concepts with which he works. This is so obvious a truism that it certainly needs no extended discussion, and yet there seem to be many people who do not understand it. A scientist must have a clear understanding of all of the concepts with which he works and the verbal expression of that clear understanding is the definition.

One of the causes of the difficulties that many students have with chemistry is a lack of realization on their part of this difference between their social and humanities studies and their studies in the physical sciences. They do not realize that chemistry books are meant to be studied in detail, not skimmed. Their chief objection to problems, when one comes right down to it, is not so much the simple arithmetic involved as it is the careful reasoning required, the necessity of realizing *exactly* what one is required to do in the problem, and the fact that the steps to be taken to arrive at the answer must be taken carefully. In their studies before chemistry, this exactness has been missing. It is much as though all their lives they had been looking at nonobjective art where general form and color were all that mattered, and then suddenly were confronted for the first time by a Dutch Master in which detail is so important that the master painter is said to have spent days in painting a lady's hand.

Students often ask me whether they should memorize definitions. To this my answer is always, "Not if you can express the same concept in your own words." The trouble is that, in general, students do not get a clear concept of the thing being defined and they often are quite unable to express themselves so as to state definitely and clearly the concept they do have. It takes time to make them realize that a definition in chemistry has meaning with a degree of preciseness not common to many other fields of learning—and those fields are usually the ones in which the student has been immersed.

At this point it is important to define the word *definition*. To start with, there are some things definitions are not. Definitions are not lists of examples of the concept being defined regardless of how apt they may be. If one asks for a definition of solution and is given sugar and water as an example, that is true—but it is not a definition. A great many youngsters in first-year chemistry think it is. A second thing that a definition is not is a statement of how one can compute the quantity being defined. If in defining the watt one says that the number of watts is equal to the number of amperes times the number of volts, that is indeed a true statement of how one computes the number of watts—but it is not a definition of the watt.

The copy of *Webster's Collegiate Dictionary* which my sister gave me when I graduated from high school defined the word definition as "an explanation of the meaning of a word or term." A definition, therefore, must state the *meaning* of the term—not how it is computed, not examples of it, not equivalents, not comparison with similar or slightly different terms, but a meaning of the term itself. This meaning must be expressed precisely so that there can be no ambiguity as to what is meant by the word after it is defined. Both the person giving the definition and the person receiving it must have a good understanding of the meaning of the words used. A person, therefore, studying the physical sciences should be a frequent user of the dictionary in order that his knowledge and the meaning of words may become ever more precise. One does not ordinarily think of a physical scientist as being an avid user of the dictionary, and, alas, in all too many cases he is not. But he should be, because only as the definitions of what he works with and what he does become more and more precise, can his work itself become better.

This need for a careful understanding of the meaning of words is even more important in the sciences than in the fields of literature or history or sociology, because of the fact that in most cases scientists are under a terrific compulsion to use as few words as possible. Anyone who has ever written for one of the chemical journals, for example, knows that the editor always cuts the length of an article to the bone. To the editor of *The Journal of the American Chemical Society*, the *Reader's Digest* must seem exceedingly verbose. There is, I fear, in the current American language a tendency to substitute the use of a multitude of words not well understood for the use of a few words whose meaning is well known.

The definitions of the fundamental concepts of the physical sciences are the lifeblood of those sciences. We must understand them ourselves with the utmost clarity, and must pass on to our students a similarly clear and (how I hate the word) unambiguous understanding of their meaning. We must be perfectly clear in our concepts of the terms

(*Continued on page 154*)

DESIGN FOR A BETTER SCIENCE PROGRAM

By LEWIS H. HOLLMEYER

Assistant Superintendent of Public Instruction, State of Illinois, Springfield

A SCIENCE PROGRAM is no better than the program desired. The science program in any school district indicates how the people evaluate science. In some schools, there is no time in the day's schedule for science; no space for science experiences or activities; no money appropriated for instructional equipment; and teachers have little or no training in this area. In those schools where science is given a proportionate part of the daily program, where space is provided for science activities, where money is appropriated for suitable equipment, where teachers are employed who have had appropriate training, the people in the school community accept the idea that science is important in the lives of their children to the extent they insist that science be given due attention in the educational program.

How can we have a better science program? History can give us the answer. How did we get a better mouse trap? A better boat? A better train, automobile, or airplane? A better telephone, radio, or television? Or the many other improvements that have come about in agriculture, medicine, health, and electronics? History records that these developments have been fathered in the hearts and minds of men and women who have had a desire for improvement, who have believed that something better could be accomplished, and who have been willing to make the necessary sacrifices to reach their goal.

It would seem to follow, then, that if we are to have a better science program we will need to consider these three important factors: (1) Do we have a desire to have a better program? (2) Do we believe we can improve our present program? (3) Are we willing to make the sacrifices necessary to complete the change?

The stories of Thomas Edison and the incandescent light, Alexander Graham Bell and the telephone, George Washington Carver and the peanut, and Elizabeth Blackwell, the first woman doctor, will help us to understand that if we have a desire or a belief in something that needs to be done, we can, through persistent effort, long hours, and hard work, reach our goal.

When we speak of a better science program, we imply that certain changes need to be made. It is also true that we cannot assume that all changes will be an improvement. We must assume that in making changes, certain obstacles must be overcome; this is especially true when changes affect people. There is a certain amount of inertia in people which opposes any change. Since there are many people who are concerned with the science program, any changes that are made in the program need to be generally accepted by those who are concerned. Changes that are contemplated need careful examination and evaluation. Guideposts are essential in order that we know in what direction the changes will take us and by what route we are to travel. To illustrate: (1) We will need to know what kind of science program exists at the present time. (2) What changes do we wish to make? (3) What procedures will be followed in making the change?

Vernon L. Nickell, Illinois Superintendent of Public Instruction, believes that the greatest concern of his office is the improvement of instruction. Through the Illinois Curriculum Program, sponsored by the Superintendent of Public Instruction, a set of tools (called consensus studies) have been developed. These tools can be used by interested people in making surveys of any area of the educational program. They can be applied to determine

Science is given thoughtful consideration in Illinois public schools. An example is the program at the Lincoln-Way Community High School, New Lenox, where the photographs on this and the following two pages were taken. Below, student Thomas Dunham studies crystals as part of a class program to identify chemical compounds.

PHOTOS BY H. NEIL HARDY

Examining the growth of flowers next to the classroom window, students and teachers make a profitable field trip just outside the school door.

the kind of program that exists at the present and where possible improvements can, need, or should be made. These inventories consist of a series of questions which, when answered by administrators, teachers, parents, and students, will give clues as to what the people of the community think about the science program and what changes need to be made. In those schools where consensus studies have been used, many improvements have been made. In addition, as noted in *The Story in 19 Schools,*[1] "The findings from the basic studies conducted in schools which have Illinois Secondary School Curriculum Program sponsored developmental projects are of inestimable value in building a broadly based local consensus regarding what needs to be done and in furnishing numerous 'specifics' which merit attention. These studies are designed to help a local school system obtain facts which are basic to sound and intelligent curriculum revision."

Newspaper and magazine articles and surveys made by school people indicate that there are certain items that need attention in our science program. These include small enrollment in science classes, students' lack of interest in the science program, and manpower shortage of well-trained science teachers, scientists, engineers, and technicians. There are others who feel that the program is outdated, that it lacks continuity, that certain concepts are not presented at the time students are best able to grasp the ideas.

If there is to be a change in our science program, who "starts the ball rolling?" It may be started by a teacher, administrator, or a person or group of people within a community. It may start with any person or group of people who have a *desire* or a *belief* that some change needs to be made. Let us take a look at a hypothetical situation but one which occurs rather often.

Erlene Roberts is a seventh-grade science teacher in the Ash Plains Junior High School. The Ash Plains Junior High School is a typical junior high school with teachers who are assigned to teach the academic subjects and a daily schedule organized around class periods of 40 minutes. The educational program to which Erlene had been exposed from grade school through college kept alive her curiosity to know about things, stimulated her powers of observation, thrilled her imagination, and developed a desire to teach science in a junior high school. While in college, she had done some research in how to deal with children in improving the learning situation. She found, to her satisfaction, through experimentation, reading, and discussion that the laboratory technique was a most meaningful instructional method in helping children grow and develop physically, emotionally, socially, intellectually, and spiritually. By the time she arrived at the Ash Plains Junior High School, she was convinced that science is important in the lives of all people, that society needs the special services of scientists, engineers, and technicians; moreover, she had a desire to provide a suitable science program for the students with whom she came in contact.

In a short time, Erlene recognized that the people in the community were not aware of the importance of science in the lives of people; the Board of Education was not cognizant of the need for science in the educational program; the superintendent and the principal looked upon science as one of the isolated subjects in the curriculum, with their obligations complete if a teacher was provided who would get the students to read a science

The annual Science Open House gives students the opportunity to display and explain project work to an interested adult audience.

[1] Sandford, Charles W. and others. *The Story in 19 Schools,* Circular Series A, No. 51, Illinois Secondary School Curriculum Program, Bulletin No. 10, p. 7.

book that was furnished and pass a test on its contents. Erlene recognized this apathy on the part of the people in the community as well as within the faculty, including the principal and the superintendent. She wanted to do something about it and to help the other members of the faculty and the people within the community to understand that science is not an isolated subject, and that being with her students only 40 minutes during the day was not enough time to provide a suitable, adequate science program—not enough time to deal with real problems of children; not enough time for students to collect information; not enough time to test and evaluate their findings; not enough time to develop skills in reading science materials. She believed that by improving her methods of teaching she would improve the science program and, in turn, improve the total educational program. But to improve the science program required a change in the daily time schedule, and this involved other people (teachers, principal, superintendent, and people in the community) who would need to make some changes. Those people who would be

The open reading shelf, part of the science program at Lincoln-Way, provides graded reading materials in each classroom.

affected by the change would have to be convinced that the change would be helpful to them and they had to be agreeable to the change. This becomes more complicated as the number of people who are concerned increases.

Erlene realized that since we are living in a democratic society and our public schools are organized to promote the ideals of democracy, it is important that school people operate or proceed ac-

Group activity is encouraged in Lincoln-Way's science program. Top, old and new club officers discuss the activity schedule of the Phi-Chem Association. They are particularly concerned with a small-scale research program which they are working on with the assistance of a nearby chemical research group. Bottom, former students help evaluate the school's science and mathematics program.

cording to accepted sociological principles. Because we believe that individuals have worth and dignity, Erlene recognized that she had to consider human relations and group dynamics and be capable, through the processes of communication, of helping others understand the need for a longer class period if this change is to be successfuly completed.

Changes can be made when there is general agreement but with nonacceptances on some specifics. Improvements come when there is dissatisfaction and it is in these areas of dissatisfaction that our energies can be exerted for continuous changes for improvement.

To illustrate, Henry Ford produced the Model T and it was accepted in general, but each year new improvements were made. The Model T while acceptable at one time would not be acceptable in 1958. We have reason to expect further changes in our automobiles. The changes that are to be made must be accepted not only by the producers of the automobiles but also by the people who buy them. Techniques to get this acceptance are the same techniques that need to be used in making changes in the science program or any other area of the curriculum.

(*Continued on page 163*)

From Research to Classroom Laboratory...

Parts I and II of this article continue the series of demonstrations on the science and engineering of man's environment for healthier living (pages 15-24, February 1958 issue of *The Science Teacher;* pages 76-81, March issue). The demonstrations are the result of a distinctive program of collaboration between key secondary school science teachers in Cincinnati, Ohio and members of the staff of the Robert A. Taft Sanitary Engineering Center in Cincinnati—the research arm of the Division of Sanitary Engineering Services of the U. S. Public Health Service, Department of Health, Education, and Welfare.

In the research laboratory: Algae cultures are inspected by Raymond Hartker (left), biology teacher at Cincinnati's Hughes High School and one of the authors of this article, and C. Mervin Palmer, Sanitary Engineering Center algologist.

PUBLIC HEALTH SERVICE PHOTOS BY DON MORAN

BASIC STEPS TO TEACHING BIOASSAY OF WATER

By RAYMOND L. HARTKER
Cincinnati, Ohio, Public Schools

and CLARENCE M. TARZWELL
Chief Aquatic Biologist, Robert A. Taft Sanitary Engineering Center

and CROSWELL HENDERSON
Biologist, Robert A. Taft Sanitary Engineering Center

A Teacher-Pupil Activity for Biology Grade 9

PART I. VISUAL ANALYSES—THE MICROCOSM

Background

"Pure water" for civilian and industrial use as well as for the conservation of biological organisms is a problem facing each and every community in the United States.

To be aware of a problem and to be able to do something about its solution should be a challenge to every teacher of science. Too often, in our jet- and rocket-minded world, the problem of stimulating young minds is affixed to spectaculars such as

The visual analyses of the microcosm is the first in a sequence of interrelated bioassay teaching projects that can be incorporated into the student's classroom experience. Three additional experiments, related to bio-research at the Robert A. Taft Sanitary Engineering Center, are designed to follow this preliminary activity as further steps in the teaching of bioassay: Part II—"Chemical Examination of Water," A (see page 133) and B, suggested for pupils in grades nine, ten, or 11, and Part III—"Bioassay of Chemicals in Water," for superior students. The latter two will follow in another *TST* issue. Increased awareness of the need for research in water control problems and the knowledge that a satisfying and rewarding career can be found in such research as part of sanitary engineering are the most important outcomes of the projects in this series.

sputniks and missiles rather than to the problems of everyday living. What must be remembered is that it takes water to make bread as well as water to make steel. Sanitary engineers insure our future health as well as our national defense.

The writers do not profess to be original in their context but only wish to coordinate the facts and ideas of many other authors of similar projects and processes.

A bioassay is an examination or analysis (assay) of life (bio). Ecology, the study of environment and its relationship to an organism, is a very necessary part of bioassay. A glossary of important terms is included to emphasize that a bioassay is relative to all conditions that exist, naturally or artificially, and that each condition has an effect that must be considered in the analysis of the total bioassay.

Tropism:	The response of a bio-organism to a *stimulus*.
Chemotropism:	The response of a bio-organism to *chemicals*.
Geotropism:	The response of a bio-organism to *gravity*.
Hydrotropism:	The response of a bio-organism to *water*.
Phototropism:	The response of a bio-organism to *light*.
Thermotropism:	The response of a bio-organism to *temperature*.

The microcosm, a little world in miniature, shall be used as the media for applying the scientific method of thinking to bring about visual analysis in this bioassay of water. A microcosm can arouse much student interest. It involves many questions which require hypotheses and experimentation for solutions; they also enable the student to go far beyond the mere recall of factual information—to think clearly and scientifically with the information acquired so that he can make generalizations that should enable him to apply these to new situations which may arise in his later experience.

Statement of Problem

The purpose of this experiment is to set up a microcosm in order to illustrate visually an ecological environment. This microcosm enables the student to apply the scientific method of problem solving to a changing balance in a marine environment, observing the results of such change and determining why the changes occurred.

Materials

A. A five-gallon bottle
B. Sand
C. Several aquatic plants *(vallisneria)*
D. Filamentous algae
E. Several small water snails
F. One small, healthy goldfish
G. A cork to fit the mouth of the bottle
H. Paraffin
I. Long hooked wire or tweezers

Procedure

1. Place two inches of sand in the bottom of the bottle.
2. Carefully anchor the *vallisneria* in the sand using long tweezers or a hooked wire.
3. Add water to a level about three-fifths of the way up the side of the bottle.

In the classroom: Measurement of reagent quantity calls for close attention from two Hughes High School students.

4. Add a small amount of filamentous algae, several small water snails, and the small goldfish.
5. Press the cork tightly into the neck of the bottle and cover with a heavy layer of melted paraffin.
6. Place the microcosm in the classroom.
7. As students evidence an interest, record their questions for follow-up.

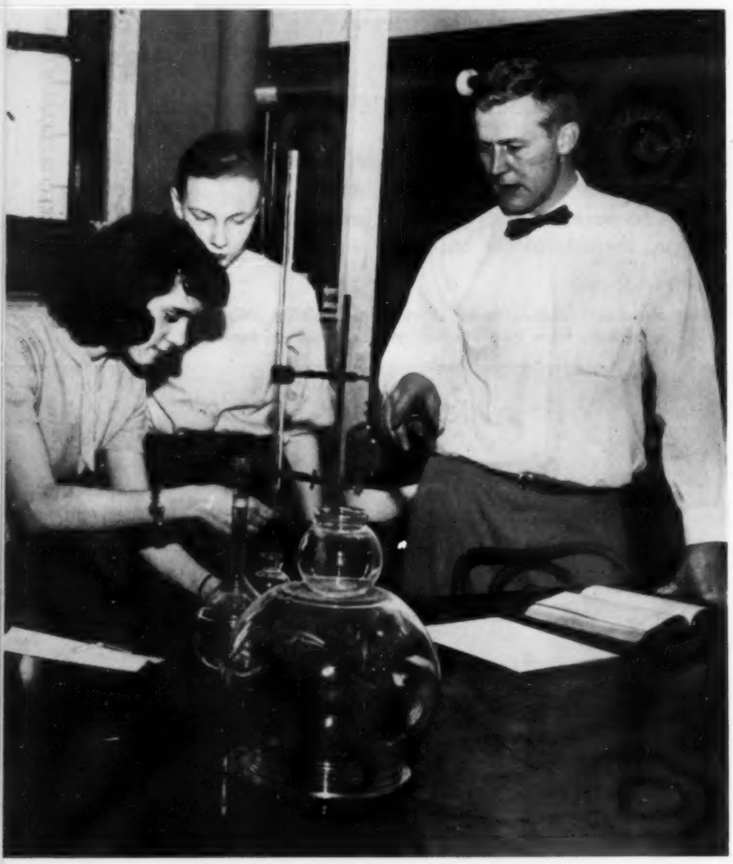
Questions Asked by Students

How long can the fish live sealed in the bottle?
How does the fish obtain continued oxygen?
Why doesn't the fish starve?
Will the fish eat the snails?
What happens to the carbon dioxide?
Is air necessary for plants to remain alive?
If the water is not changed, will it become foul?
Do water forms need air to live or do they just breathe water?
Does temperature have any effect on the plant and water life?

Follow-up

Interest is a wonderful aid to learning. Once students are interested in the microcosm and the questions it poses, it is almost impossible to stop their wanting to find out the answers to their questions. The student awareness of the problem now existing sets the stage for the use of the scientific method of solution.

Teacher Hartker explains titration, last step in the DO determination. Sophomore student Janet Gausmann, left, is releasing sodium thiosulfate solution from a burette while fellow student Lea Kalejs watches.



Divide the class into groups according to individual interests and abilities. Let each group choose the problem they would like to attack. These involve respiration, food, pollution, and ecology. Encourage pupils to post hypotheses, discuss them, and propose methods for trying them out. Some will be discarded as the group thinks them through. Others will be investigated through reading, experimentation involving observation, and the drawing of conclusions. Provide as many resources as you can for the students to use in testing their hypotheses. Let each group report their conclusions to the rest of the class.

Students of many biology classes had the experience of working with the microcosm. Pupil inquiries, related to an alteration of the original project, resulted in such questions as:

1. What would happen if the microcosm was placed in the sunlight or in the shade for a week's time? (Phototropism)
2. Does temperature affect the microcosm? (Thermotropism)
3. What would happen if sewage or industrial type waste was put into the microcosm? (Chemotropism)
4. What if several goldfish were put into the bottle? (Ecology)

These questions led to students setting up additional microcosms to try out by experiment the effect of sunlight, darkness, temperature, pollutants, and additional water life on the balance of the microcosm. As these experiments are concluded, student committees should report their findings to the rest of the class so that their research can be shared by all.

Teacher and students soon found that their research led to many questions whose solution lay beyond the present realm of knowledge of the pupils. Sufficient interest was developed so that through teacher-pupil planning many desired to expand their knowledge beyond the visual bioassay and preparations were begun to consider such problems as:

A. How do you know or measure the amount of oxygen in the water? (Winkler process)
B. Does the chemistry of the water change with the amount of light or with the decaying of organic materials in the water? (Determination of *p*H)
C. How much industrial pollution does it require to kill fish? (Parts per million of solute toxic in water)

These questions are the basis for Part II—"Chemical Examination of Water," A and B, and Part III—"Bioassay of Chemicals in Water."

Some Other Learning Experiences

1. Visit the city water works to inquire as to the effect of industrial toxicants, sewage, and other wastes on our water supply.
2. Collect water from various ponds and streams. Place live guppies in these samples and see if they will support life.
3. Investigate problems of sewage disposal.
4. Invite persons in charge of water conservation in industry as guest speakers in the classroom. Ask them to discuss the following questions:
   a. What does industry do to prevent pollution in streams?
   b. Why does industry demand a good water supply before moving into an area?
   c. How are toxicants best removed?
   d. How long have we been aware of industrial wastes as a biological problem?
   e. What are some of the more harmful wastes?

References

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The authors would like to acknowledge the assistance of Dr. William A. Dreyer, University of Cincinnati, and Howard R. Thomas and Walter A. Warner, biology teachers, Hughes High School, Cincinnati.

A Teacher-Pupil Activity for Biological Science Grades 9, 10, or 11

PART II. CHEMICAL EXAMINATION OF WATER

A. Winkler Method, Unmodified for the Determination of Dissolved Oxygen in Water

Background

An adequate supply of dissolved oxygen, DO, is necessary for the life of fish and other aquatic organisms. The DO concentration at any one time indicates the septicity of the water or the satisfactory environmental condition for aquatic life. A series of measurements of DO may indicate the photosynthetic activity and biochemical oxygen demand.

In the determination of the dissolved oxygen in water, various ions and compounds may cause interference. In correcting for these interferences numerous modifications of methods have been proposed. These modifications are given in *Standard Methods for the Examination of Water, Sewage, and Industrial Wastes,* published by the American Public Health Association, Inc., 1790 Broadway, New York 19, New York. For field work and extensive aquarium analysis for DO, the teacher should be prepared to use modifications noted in the above reference. The Winkler method will be described below for the determination of dissolved oxygen in water.

The basic Winkler procedure entails the oxidation of manganous hydroxide in a highly alkaline solution. Upon acidification in the presence of an iodide, the manganic hydroxide dissolves and free iodine is liberated in an amount equivalent to the oxygen originally dissolved in the sample. The free iodine is titrated with a standard sodium thiosulfate solution, using starch as an internal indicator after most of the iodine has been reduced. The normality of the thiosulfate solution is adjusted so that one ml is equivalent to one mg/liter of dissolved oxygen when 200 ml of the original sample is titrated.

It should be noted that the water supply may contain interferences such as nitrates, ferrous and ferric iron, organic matter, sulfides, sulfites, polythionates, hypochlorites, suspended matter, and other oxidizing and reducing substances that may

interfere with the Winkler test either by absorbing or reducing the liberated iodine or oxidizing the iodide to free the iodine.

Most natural waters, which support aquatic life, do not normally require a modification of the process for the determination of DO. The standard Winkler procedure is generally adequate. Modifications are usually necessary only when waters contain high concentrations of organic material or sulfite wastes.

Statement of the Problem

The purpose of this experiment is to show the student how the sanitary engineer, aquatic biologist, or allied professional person determines the amount of dissolved oxygen in streams, ponds, and lakes.

Materials

A. Several 250- or 300-ml capacity bottles with stoppers
B. Four pipettes, two ml, graduated in 1/10 ml or four eye droppers file-marked at one and two ml
C. Four 1000-ml flasks
D. One graduated burette, 50-ml capacity
E. One ring stand and burette holder
F. Crystalline manganous sulfate: $MnSO_4 \cdot 4H_2O$, $MnSO_4 \cdot 2H_2O$, or $MnSO_4 \cdot H_2O$.
G. Four or five liters of distilled water
H. Sodium hydroxide or potassium hydroxide; sodium iodide or potassium iodide; sulfuric acid, 36N; potassium bi-iodate or potassium dichromate; sodium thiosulfate.

Reagents

Make up the reagents according to directions.

Manganous sulfate solution: Dissolve 480 g $MnSO_4 \cdot 4H_2O$ or 400 g $MnSO_4 \cdot 2H_2O$ or 364 g $MnSO_4 \cdot H_2O$ in distilled water, filter, and dilute to one liter. When uncertainty exists regarding the amount of water of crystallization, a solution of equivalent strength may be obtained by adjusting the specific gravity of the solution to a value of 1.270 at 20 degrees C. The manganous sulfate solution should not liberate more than a trace of the iodine when added to an acidified solution of potassium iodide.

Alkaline iodide reagent: Dissolve 500 g NaOH or 700 g KOH, and 135 g NaI or 150 g KI, in distilled water and dilute to one liter. Potassium and sodium salts may be used interchangeably. The reagent should not give a color with starch solution when diluted and acidified.

Sulfuric acid, concentrated: The strength of this acid is about 36N. Hence, one ml is equivalent to about three ml of the alkaline-iodide reagent.

Starch solution: An emulsion of five to six g potato, arrowroot, or soluble starch is made in a mortar or beaker with a small quantity of distilled water. Pour this emulsion into one liter of boiling water, allow to boil a few minutes and settle over night. Use the clear supernatant. This solution may be preserved with 1.25 g salicylic acid per liter or by the addition of a few drops of toluene.

Standard potassium bi-iodate solution: A stock solution equivalent in strength to 0.1N thiosulfate solution contains 3.250 g $KIO_3 \cdot HIO_3$ per liter in accordance with the following reaction: 2 $KIO_3 \cdot HIO_3$ plus 20 KI plus 11 H_2SO_4 yields 11 K_2SO_4 plus 12 H_2O plus 12 I_2. The bi-iodate solution is equivalent to the 0.025N thiosulfate, contains 0.8124 g $KIO_3 \cdot HIO_3$ and may be prepared by diluting 250 ml of the stock solution to one liter.

Standard potassium dichromate solution: $K_2Cr_2O_7$ may be substituted for $KIO_3 \cdot HIO_3$. The $K_2Cr_2O_7$ should be previously dried at 103 degrees C for two hours. A solution equivalent to 0.025N sodium thiosulfate contains 1.226 g $K_2Cr_2O_7$ per liter.

Sodium thiosulfate stock solution, 1.N: Dissolve 248.2 g $Na_2S_2O_3 \cdot 5H_2O$ in boiled and cooled distilled water and dilute to one liter. Preserve by adding five ml of chloroform or one g NaOH per liter.

Standard sodium thiosulfate solution, 0.025N: Prepared by (a) diluting 25 ml sodium thiosulfate stock solution to a liter, or (b) dissolving 6.205 g $Na_2S_2O_3 \cdot 5H_2O$ in freshly boiled and cooled distilled water and diluting to one liter. Standard sodium thiosulfate solution may be preserved by adding five ml of chloroform or 0.4 g NaOH per liter.

Standardization with bi-iodate: Dissolve approximately two g potassium iodide, free from iodate, in an Erlenmeyer flask with 100 to 150 ml of distilled water, add ten ml of dilute H_2SO_4 (one part concentrated H_2SO_4 to nine parts of distilled water) followed by exactly 20 ml standard 0.025N bi-iodate solution. Dilute to 200 ml and titrate the liberated iodine with the thiosulfate solution, adding starch toward the end of the titration, when a pale straw color is reached. Exactly 20 ml of 0.025N thiosulfate should be required when the solutions under comparison are equal strength. It is convenient to adjust the solution to exactly 0.025N. One ml 0.025N thiosulfate is equivalent to 0.2 mg of oxygen.

Standardization with dichromate: Same as above except that 20 ml standard dichromate is used in place of the 0.025N bi-iodate. Place in the dark for five minutes, dilute to approximately 400 ml, and titrate with 0.025N thiosulfate.

Procedure

Collection of Samples. Collect the samples in narrow-mouth glass stoppered bottles of 250- to 300-ml capacity. Special precautions are required to avoid entrainment or solution of the atmospheric oxygen. In sampling from a line under pressure, a glass or rubber tube attached to the tap should extend to the bottom of the bottle. Allow the bottle to overflow two or three times its volume and replace the stopper so that no air bubbles are entrained.

Samplers which permit collection of the dissolved oxygen, biochemical oxygen demand (BOD), and other samples from streams, ponds, or tanks of moderate depth are illustrated in the reference given in the background material. Water from depth samples taken in a one- to three-liter Kemmerer sampler is bled from the bottom through a tube extending to the bottom of a 250- to 300-ml dissolved oxygen bottle. In sampling from a reservoir at considerable depth a sampler provided with a valve release should be used. The temperature of the sampled water should be recorded to the nearest degree centigrade.

Preservation of Samples. There should be no delay in the determination of the dissolved oxygen of all the samples that contain an appreciable iodine demand or ferric iron. Preservation of samples for four to eight hours is accomplished by adding 0.7 ml conc. H_2SO_4 and one ml of two per cent sodium azide to the sample in the dissolved oxygen bottle. This will arrest the biological activity and maintain the dissolved oxygen if the bottle is stored at the temperature of collection or water sealed and kept at a temperature of ten to 20 degrees C. As soon as possible, complete preparation of the sample.

Preparation of Samples. To the sample as collected in the 250- to 300-ml bottle add two ml* $MnSO_4$ solution followed by two ml alkaline-iodide reagent well below the surface of the liquid, stopper with care to completely exclude air bubbles, and mix by inverting the bottle several times. When the precipitate settles leaving a clear supernatant above the manganese hydroxide floc, repeat the shaking a second time. With sea water a ten-minute period of contact with the precipitate will be required. When settling has produced at least 100 ml of clear supernatant, carefully remove the stopper and immediately add 2.0 ml conc. H_2SO_4 by allowing the acid to run down the neck of the bottle; restopper and mix by gentle inversion until the solution is complete. The iodine should be uniformly distributed throughout the bottle before decanting the amount needed for titration. This should correspond to 200 ml of original sample after correction for the loss of sample by displacement with the reagents has been made. Thus when a total of four ml, two ml each of the manganous sulfate and alkaline-iodide reagents, is added to a 300-ml bottle, the volume taken for titration should be:

$$200 \times \frac{300}{300-4} = 203 \text{ ml}$$

Titrate with 0.025N sodium thiosulfate to a pale straw color. Add one to two ml of freshly prepared starch solution and continue the titration to the first disappearance of the blue color. If the end point is overrun, the sample may be back titrated with 0.025N bi-iodate added drop-wise or by an additional measured volume of sample. Correction for the amount of bi-iodate or sample should be made. Subsequent recolorations due to the catalytic effect of nitrites or to the presence of traces of ferric salts which have not been complexed with fluoride should be disregarded.

Studying the Sanitary Engineering Center's water supply and water pollution program, Mr. Hartker inspects a fish toxicity experiment room. With him are the Center's director, Harry G. Hanson, and C. M. Tarzwell (right), chief of aquatic biology and one of the authors of this article.

*The change in the volume of reagents is made because two ml of reagents insure better contact of reagents and sample with less agitation. It is still permissible to use one ml reagent quantities with 250-ml bottles.

Calculation

Since one ml of 0.025N $Na_2S_2O_3$ is equivalent to 0.2 mg oxygen, the number of ml of sodium thiosulfate used is equivalent to the mg/liter of dissolved oxygen if a volume equal to 200 ml of original sample is titrated.

In a classroom determination of DO, ten ml of sodium thiosulfate were used in the titration. Using the formula:

$$\frac{200 \times \text{ml of sodium thiosulfate}}{203}$$

and substituting: $\frac{200 \times 10}{203} = 9.85$ mg/liter or 9.85 parts/million

Some Other Learning Experiences

1. Collect water samples from ponds, streams, and lakes and run a determination for dissolved oxygen. Compare.
2. Take water samples from your microcosms and run a determination for dissolved oxygen. Compare.
3. Invite an aquatic biologist to talk to the class.
4. Determine the effect of various pollutants upon the amount of dissolved oxygen in water.
5. If possible visit a government biological experimental station to study aquatic ecology.

Application of the Winkler Method

This method could be used to:

1. Determine the amount of oxygen resulting from the phototropic effects in aquaria placed in bright light as compared to aquaria placed in dim light.
2. Determine the amount of DO when many goldfish are placed in an aquaria as compared to just a few. (ecology and BOD)
3. Examine ponds and streams on field trips for DO and ecological purposes.
4. Check local drinking water supply.
5. Determine the amount of O_2 used to oxidize organic materials commonly disposed of through sewage. (closed and sealed bottle required)

Part II-B of the Chemical Examination of Water, an activity to follow, is designed to enable the student to study the pH and hardness of water.

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FACT SHEET ON SATELLITES

The following comparisons of the first two earth satellites successfully launched by each of the U.S. and Soviet governments are based on figures announced by the respective governments. Where possible, they have been checked by the U.S. Naval Research Laboratory.

	EXPLORER I	VANGUARD I	SPUTNIK I	SPUTNIK II
Weight	30.8 pounds	3.25 pounds	184 pounds	1120 pounds
Shape	Cylindrical	Sphere	Sphere	Cylindrical
Dimensions	80″ long; 6″ in diameter	6.4″ in diameter	22.8″ in diameter	19′ long; 4′ in diameter
Speed	About 16,000 mph	18,000–19,000 mph	18,000 mph	17,840 mph
Initial Orbit Time	114.8 minutes	134 minutes	96.25 minutes	103.3 minutes
Maximum Altitude	1573 miles	2466 miles	598 miles	1009 miles
Minimum Altitude	224 miles	404 miles	138 miles	132 miles
Angle to Equatorial Plane	33.5 degrees	34.1 degrees	65 degrees	65 degrees
Date Launched	Jan. 31, 1958	March 17, 1958	Oct. 4, 1957	Nov. 3, 1957
Lifetime	Several years	5–10 years	3 months, then disintegrated	End predicted for mid-April 1958 (at press-time)
Payload	11 pounds of instruments	Batteries and radio	Batteries and radio	Dog and instruments

NEW DIRECTIONS FOR SCIENCE EDUCATION RESEARCH

By JOHN H. WOODBURN
The Johns Hopkins University, Baltimore, Maryland

DOES the old wheeze about hunting for the lost wallet under the street lamp "where the light is" rather than in the darkness where it was lost, hold meaning for research in science education nowadays? To shed some light on this question, a group of young teachers yet to be led into traditional areas of science education research were asked: What contribution over and above the meeting of your classes would you like to make to the profession of science education?

Although many of their answers point toward traditional research areas, others may give some new directions to those people who prefer groping wherever the most significant answers are likely to be found rather than "where the light is." Here are questions that suggest new directions.

What are the characteristics of the best science program for one-science teacher schools, that is, schools with a total senior high enrollment of 200 pupils or less?

What worthwhile relationships can be established between science teachers, their students, and science-related enterprises within the community?

How can a teacher "see" the image which his new students have of him and the subject he teaches? Do students think, for example, that teachers are people who are incapable of doing anything but teach?

What are the criteria for a cooperative course of study for physics and mathematics teachers?

Does the usual textbook treatment of evolution present the most meaningful evidence bearing on the topic?

Do high school biology, chemistry, and physics courses take their students equal distances into the respective sciences? Has each advanced equally along the maturity spectrum—observation, description, measurement, classification, and establishment of relationships?

Does the fusion of physics and chemistry into a physical science course hold the same promise for the latter half of the 20th century that the fusion of zoology and botany into a biological science course did for the first half?

Are there basic principles of science included in the general science program for which available demonstrations and/or laboratory exercises are inadequate?

Are abstract science and mathematics concepts easier for the students to grasp when presented with teaching aids?

Is there a need for a government academy to train a hard core of the nation's science teachers?

Can TV programs educate the public on scientific developments and methods of research and investigation?

Should there be subsidized institutes allowing teachers to be brought up to date on the tactics and subject matter of science teaching? If so, what should be their characteristics?

How can biology, a scientific subject, be presented more scientifically?

Should science teachers train scientific and technical writers?

For topics which recur in elementary, junior high, senior high, college, and graduate school courses what are the optimum depths for each grade level at which science teaching should be focused?

What are the science teacher's responsibilities regarding the public's attitude toward the importance of science?

Are the satisfactions to be gained from causing students to extend themselves beyond their capacities adequate to justify the necessary effort on the part of the teacher?

What are the criteria of good relations between high school and college science faculties and who measures them?

What are the science teacher's responsibilities for the social implications and consequences of science?

What specific aspects of a student's success or failure in college science courses can be traced to success or failure in high school science courses?

What specific aspects of success or failure in a science course can be traced to success or failure in prior or concurrent mathematics courses?

Is the ability or inability to benefit from various types of laboratory instruction correlated with other factors known to influence learning? For example, do bright and dull students benefit equally from the "against par" type of physics exercise?

Should the laboratory be used to "prove" the laws of nature or to provide opportunities for the student to see how these laws operate in naturally occurring events and circumstances?

A Look at British Secondary Science Education

By MARGARET J. McKIBBEN
Oak Park and River Forest High School, Oak Park, Illinois

A MAJOR CONCERN OF EDUCATORS in the United States is that Russia has surpassed us in the training of scientists, technicians, and engineers. Recent criticism has been leveled chiefly at the inefficiency of the high school. Many of us have an "academic inferiority complex" about our educational system when talking to Europeans, because we feel that children abroad are further advanced in their subjects (including the sciences) than ours. Whether these criticisms and feelings are justified is one question; what we can do to upgrade our science training at the secondary level is another and more pertinent one for us to ask ourselves.

Since no comparable data are available for the products of British secondary schools and American high school graduates, no final statement can be made concerning the relative merits of the two systems. However, it behooves us to learn all we can about the training of scientists in other countries in order to improve our own system.

Since university preparation in England is almost exclusively the job of grammar schools and of the so-called "public schools," such as Eton and Harrow, it is with these two types of schools that we are concerned in learning what we can about the training of scientists. Entrance to the grammar schools is based on results of the Eleven Plus Examination given in primary schools to children about the age of 11. The top 15 per cent, as determined by these examinations, are admitted to grammar schools. The public schools are secondary schools with students of similar ability.

University entrance is by examination. These, called the General Certificate of Education examinations, are given in the fifth and sixth forms (corresponding to our 11th and 12th grades) of both grammar and public schools. Their significance lies in the fact that they determine to a large extent the content of the courses in both of these types of schools.

They may be taken at one of three levels—ordinary, advanced, and scholarship. The universities require a certain number of passes at the advanced level in addition to a certain distribution in subject-matter areas. London, Oxford, and Cambridge offer their own G.C.E. examinations. The northern universities including Birmingham, Liverpool, and Manchester have combined in this matter and give one which meets their common needs, and the newer universities (Nottingham, Southampton, and Exeter) tend to use the University of London examinations.

Except for the practical sections of the examinations at the advanced and scholarship levels, the questions asked are largely of the essay type requiring recall of detailed factual information. A description of the zoology examination at the advanced level for which the writer prepared girls will give an idea of the others. It consisted of three three-hour sections. The first and second of these, administered at the school, were written papers covering invertebrates and vertebrates respectively.

Two examples taken from a recent zoology examination indicate that the level of difficulty of advanced level G.C.E. examinations and consequently the sixth-form courses preparing for them is roughly that of accelerated high school science courses being accepted for advanced college standing in this country. This question is from the vertebrate paper: "Make large, labelled drawings of transverse sections through (a) the region of the stomach of a whole female dogfish, and (b) the intestinal region of a whole amphioxus. Comment on the differences shown by these two sections."[1] The following one is from the invertebrate section: "The crayfish is a triploblastic, metamerically segmented coelomate animal. Explain fully what is meant by this statement."

The third part, given at a university examination center, was of a practical type requiring the microscopic identification of tissues, the preparation of

The writer, a biology teacher, taught under the Fulbright Exchange Program in a grammar (secondary) school in London during the past school year. While in England, she had the opportunity to visit schools recommended for their excellence in science education. This article is based on her observations in six grammar schools and two public schools.

[1] General Certificate of Education Examination, Advanced Level, Summer 1957, University of London.

a permanent mount slide, and the dissection of the circulatory system of the dogfish shark. Questions on the ordinary level papers would be less difficult and on the scholarship level papers more difficult. Those in the practical sections of the physics and chemistry examinations involved the use of materials and equipment of those subjects.

A study of G.C.E. questions in science covering a ten-year period indicates that the main objective has been the recall of facts and principles. In the last year or so, however, a few questions involving skill in problem-solving techniques have been introduced into the papers. Because of the influence exerted by the examinations on the secondary course content, increased emphasis on interpretation of data, applying facts and principles, and other aspects of the scientific method in grammar schools and public schools may be expected in the future.

Apart from these "external" examinations were the "internal" ones given by the masters at the end of each term to determine the grade for the course and class standing. Questions on these were of the essay type and answers were graded on the basis of demonstrated knowledge of the subject, organization of ideas, grammar, and penmanship.

Laboratory Work and Equipment

Considerable attention was given to laboratory activities in the schools visited, especially at the upper levels, as well as on the G.C.E. examinations. Much of the laboratory work is of the direction-following type. This is not always the case, however. In one of the upper form classes in physics each of the seven students in the class had been given a card containing the statement of a problem. All necessary equipment had been made available and each boy was at work solving his individual problem.

Laboratory equipment and facilities in the schools visited were comparable to those found in our better science departments. In addition, the local county councils provided free of charge such expendable materials as chemicals and live and preserved material for study in state-aided schools. Films and filmstrips of good quality were available free of charge from the same sources. The London County Council gave especially good service in these respects. But of greatest value of all (at least to the writer) was the laboratory assistant system. Under this system laboratory girls in girls' schools and laboratory boys in boys' schools assist the teachers by setting up equipment for demonstrations, getting out and putting away materials for laboratory periods, projecting films, and otherwise

(Continued on page 159)

BULLETIN BOARD

Bulletin Board is *The Science Teacher's* "catchall" feature and will appear when pertinent items warrant its publication. It will carry notices from *TST's* editors, from NSTA, and from NSTA members or other science teachers who may wish to use it. Its subject matter can be classified "miscellaneous," the basic qualification being that the notice is of interest to science teachers. No commercial items, of course—and *TST's* editors reserve the right to determine the publication suitability of notices submitted. Write to: Bulletin Board Editor, *The Science Teacher*, 1201 Sixteenth Street, N.W., Washington 6, D. C.

IGY BULLETIN: This official monthly publication of the U.S. National Committee for the International Geophysical Year is now available by subscription at special rates for science teachers and their students. The *Bulletin* contains brief articles and reports on IGY programs in a dozen different scientific fields. Each subscription will include all back issues, dating from July 1957, as well as all future issues—at least through December 1958, possibly through June 1959. Special rates are: $3.50 each for individual subscriptions, $3 each for five or more subscriptions mailed to a single address. Write to: Publications Office, National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D.C.

"OPEN-ENDED" CHEMISTRY EXPERIMENTS: A second group of eight pretested experiments for senior high schools has been produced by the Manufacturing Chemists' Association. Subjects are: Reaction Between Zinc and Nitric Acid, Corrosion of Iron, Oxidation and Reduction, Catalysis, Finding Molecular Weights, Strength of Sodium Hypochlorite Solution, Rate of Reaction as Determined by Strong and Weak Acids, and Rubber. Each school may obtain free for each experiment 30 student guides and one teacher information sheet; additional materials are two cents per sheet. For order forms write to: Director of Education, Manufacturing Chemists' Association, Inc., 1625 Eye Street, N.W., Washington 6, D.C.

SCHOOL ADMINISTRATORS' REPORTS: *Education at Weeks*, subtitled "A Junior High School Builds Its Program. . . . ," is an example of recent excellent reports by school administrators including accounts of their school science programs. Among others are reports for Cleveland, Ohio; Cincinnati, Ohio; and Lincoln, Nebraska. Commonly these are available in single copies free or at low cost. The Weeks report, on Weeks Junior High School, Newton Centre, Massachusetts, is $1.25. For a copy write to: Donald K. Davidson, Principal, Weeks Junior High School.

Classroom Ideas

Chemistry

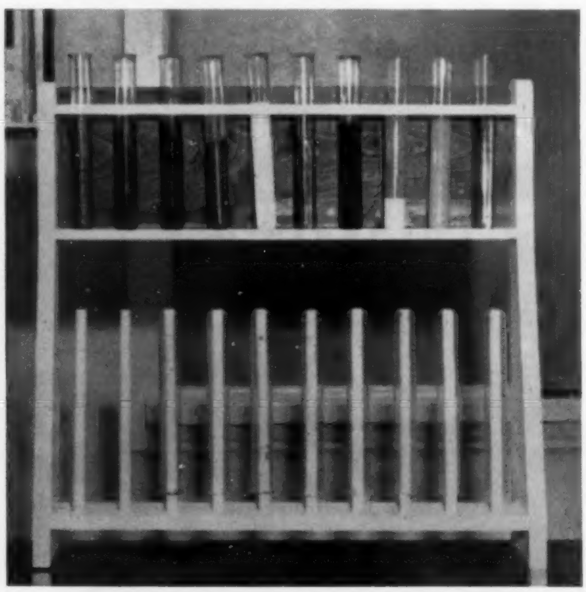
Making Chemistry Demonstrations Visual

By CECIL E. PETIT, Chemistry Instructor, Grants Pass, Oregon, High School

Semimicro techniques and the use of small quantities of materials have proved valuable in the chemistry laboratory. However, for demonstrations that are to be observed by the entire class, they are usually inadequate. For most students in the back row to observe what is taking place in test tube demonstrations, it is desirable to use large one-inch test tubes.

This often presents a problem, since the standard test tube rack is not built to take tubes of this size. Also, demonstrations that are run at desk level are difficult to observe. To overcome these difficulties, a special demonstration desk rack has proven useful.

The rack stands 20 inches high and has a base seven inches wide. The length is 22 inches to allow ten holes 1-1/8 inches in diameter spaced two inches on center. The drying pins are made excessively long—nine inches—to permit complete drying of test tubes between demonstrations.



A working drawing of this apparatus may be obtained by sending a stamped envelope to the author.

An added feature is the sliding panel back of the test tubes. This is painted black on one side for demonstrations giving light colors and white on the other side for reactions that are dark.

Biology

A Plant Growth Experiment

By RUSSELL PENGELLY, Klamath Falls, Oregon

I have been carrying out this experiment for about four months. It is the growing of duckweed *Lemma minor* in an airtight jar of water. It is a simple experiment and can teach children of all ages a great deal about plant growth.

I used a bottle 4½ inches tall and two inches in diameter. This was half filled with water and then some 25 duckweed plants were placed in the water. The lid was then put on as tight as it could be turned with the hope of making the jar airtight. After a week I found a small snail in the bottle. I left it there; eventually it died.

Some points to be made about this experiment are the following.

1. One can watch the roots develop; the root caps are large and can be seen very easily.
2. Some of the plants die, but others develop to take their place.
3. It can be shown that the plants use and make both carbon dioxide and oxygen.
4. There will be interest in why the plants do not need "air."

For the project-minded student this should suggest various questions. For example, what is the average concentration of carbon dioxide in the air when the jar is in the sunlight? What is the concentration after the jar has been in the dark for some time? What is the average *p*H of the water and how does it change? What is the average number of plants this environment will maintain? If the duckweed is grown under different temperature conditions, will this affect its growth rate?

This is one of those simple experiments that is very easy to do. But the number of things one can do with it is limited only by the ability and imagination of the people working with it.

Physics

A Classroom Demonstration of a Series-Parallel Circuit and the Heating Effects of an Electric Current

By WENDELL F. BENNETT, Head of Science Department, Natick, Massachusetts, High School

Once my physics students have completed a laboratory exercise on "fall of potential," I generally perform the demonstration outlined here. First, I review their experiment on fall of potential, and introduce the subject of the series-parallel circuit. Since the demonstration also involves the heating effect of an electric current, I explain to them that the calories of heat produced are a product of I^2R times a constant (which they will later determine by experimentation).

I use two pieces of wire, each 50 cm long. One wire is copper, B & S gauge DCC number 30; the other is bare iron wire, number 35.

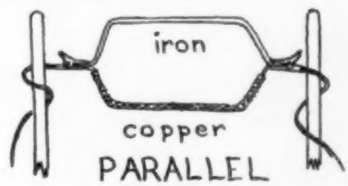
The series circuit is demonstrated first, using 24 VDC for the potential. I call on one of my students to assist me, connect my wires together in series, and ask the class to observe and make notes on their observations. The circuit is then closed. The iron wire becomes red hot, and should be clearly visible to the class. In case the glowing wire is not visible to the class, my assistant cuts a piece of paper with the hot wire. I then have him feel of the copper wire, and tell the class whether it is hot or cool.

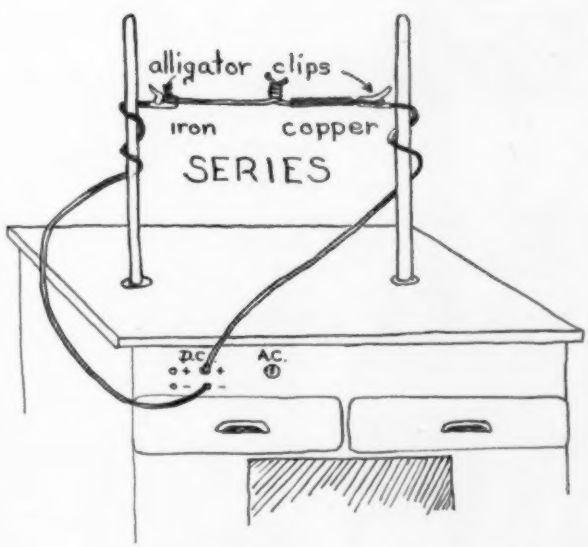
After answering any questions that may be asked, but making no explanations of the reasons "why," my assistant then disconnects the two wires, and reconnects them in parallel. My source of potential is now changed to 6 VDC. (Note: We have a control panel, with two circuits at my bench. One circuit has 24 V, while the other has 6 V placed on it. Dry cells or storage batteries will work equally as well.)

It is necessary to leave the circuit closed for only a few moments in order to have the heating effect in the copper wire cause the cotton covering to start smoking. At the same time I have my assistant feel of the iron wire and determine its relative temperature. If the circuit is left closed too long, however, the copper wire will break or burn through. I try to stop the demonstration before that point is reached.

Again I answer any questions pertaining to the demonstration itself, and then allow the class a few minutes to analyze their observations and to prepare a written explanation of the "why" of the demonstration.

The principal advantage of this experiment is its simplicity. It is very easy to set up and easy to demonstrate; it is clearly visible to all parts of the classroom; and perhaps most important of all, it makes student understanding of the nature of the series-parallel circuit much greater.





NSTA Officers and Directors for 1958-59

Under the revised constitution which became effective December 26, 1957, seven officers and directors were chosen by membership ballot in the NSTA 1958 elections. The secretary will serve for two years; the treasurer elected this year will serve for one but succeeding terms for this post will be of two-year duration. The post of alternate director has been eliminated, but those elected last year will serve out their two-year terms.

The new administration, including ten officials who are holdovers from previous elections, takes office July 1, 1958. The incoming Board of Directors is listed below (asterisks appear before the names of those officials selected in the 1958 elections).

Herbert A. Smith, above, President 1958-59. Professor of Education and Director, Bureau of Educational Research and Service, University of Kansas, Lawrence. Formerly science teacher, Nebraska high schools; author of numerous articles in science journals. Formerly NSTA Region VII Director.

Glenn O. Blough, right, Retiring President 1958-59. Associate Professor of Education, University of Maryland, College Park. Formerly Specialist for Elementary Science, U. S. Office of Education, Washington, D. C. Author and co-author of more than two dozen books including "Elementary School Science and How to Teach It" and many books for children.

Donald G. Decker, left, President-elect 1958-59. Chairman, Division of the Sciences; Director, Laboratory School; Director, Summer Sessions; Director of Instruction; Colorado State College, Greeley. During war years, worked with Manhattan Project, Oak Ridge, Tennessee. Chairman, Planning Committee, 1958 NSTA Convention. Author and filmstrip consultant.

BOARD OF DIRECTORS

Executive Committee

President: Herbert A. Smith
Retiring President: Glenn O. Blough
***President-elect:** Donald G. Decker
***Secretary:** Sylvia Neivert
***Treasurer:** Robert T. Lagemann (re-elected)
Executive Secretary: Robert H. Carleton, NSTA headquarters, Washington, D. C.

Directors

REGION I: (1958-59) **Director**—Dorothy W. Gifford, Head, Science Department, Lincoln School, Providence, Rhode Island. **Alternate Director**—Clifford R. Nelson, Junior High School Science Consultant, Weeks Junior High School, Newton Centre, Massachusetts.

Sylvia Neivert, left, Secretary 1958-60. Chairman, Science Department, Bay Ridge High School, New York City. Contributor to New York City professional journals. Member of NSTA Publications Committee; Executive Board, New York City Biology Teachers Association.

Robert T. Lagemann, right, Treasurer 1958-59. Chairman, Department of Physics and Astronomy, Vanderbilt University, Nashville, Tennessee. Currently NSTA Treasurer, formerly Region III Director. Formerly professor, Emory University; physicist, Manhattan District, World War II.

***REGION II:** (1958-60) C. Richard Snyder, Biology Teacher, Radnor High School, Wayne, Pennsylvania.

REGION III: (1958-59) **Director**—Anita Bickford, General Science Teacher, Leland Junior High School, Chevy Chase, Maryland. **Alternate Director**—Donald C. Martin, Head, Department of Physics, Marshall College, Huntington, West Virginia.

***REGION IV:** (1958-60) Archie L. Lacey, Associate Professor of Science, Grambling, Louisiana, College.

REGION V: (1958-59) **Director**—Richard W. Schulz, Department of Physics, Purdue University, Lafayette, Indiana. **Alternate Director**—C. Leroy Heinlein, General Science Teacher, Woodward High School, Cincinnati, Ohio.

***REGION VI:** (1958-60) James Hervey Shutts, Consultant in Science, Minneapolis, Minnesota, Public Schools.

REGION VII: (1958-59) **Director**—Paul A. Wilkinson, Chairman, Science Department, Manual High School, Denver, Colorado. **Alternate Director**—Horace H. Bliss, Associate Professor, Chemistry Chairman, Oklahoma Science Service, Extension Division, Univ. of Oklahoma, Norman.

***REGION VIII:** (1958-60) Eugene Roberts, Head, Science Department, Polytechnic High School, San Francisco.

Thanks to . . .

the following retiring members of the 1957-58 Board who worked diligently and enthusiastically for the Association: **Retiring President** John S. Richardson; **Secretary** H. M. Louderback; **Region II Director** Herbert Reichard; **Region IV Directors** Ernest E. Snyder and John A Manning; **Region VI Directors** Henry E. Goebel and Gertrude M. Olson; and **Region VIII Directors** Edward M. Gurr and Robert A. Rice.

STAR AWARDS

By ABRAHAM RASKIN

Secretary-Editor, STAR '58; Hunter College, New York City

THE SCIENCE TEACHER ACHIEVEMENT RECOGNITION (STAR) awards program of 1958 is the fifth program of its kind sponsored by the National Science Teachers Association. The first was conducted in 1952 and drew 57 entries; the 1953 program drew 47 entries; and the 1954 competition, 130 entries.

In 1956, the National Cancer Institute, U. S. Public Health Service, recognizing the importance of the science teacher in developing a pool of young scientists from which to recruit future leaders in research, the teaching of science, and other scientific fields, decided to support a program of science teacher recognition. The first STAR program, conducted by NSTA in 1956-1957, gained national recognition and attracted 303 entries. The second of these awards programs, STAR '58, is also supported by the National Cancer Institute. This year, despite the fact that the nature of the entry was very closely defined, there were even more entries. A total of 369 were submitted from 45 states and territories.

This year STAR was designed to stimulate and to recognize superior laboratory instruction in science in grades 7 through 12 in U. S. public, private, and parochial schools. We were interested particularly in encouraging the development of creative ideas, teaching materials, and teaching techniques related to the laboratory.

The task of judging the 369 entries was a formidable one. Gratitude is due the members of the STAR National and Advisory Committees who served on the two judging panels. The judges were Miss Mary Polk Roberts of Towson, Maryland; Dr. Margaret McKibben of Oak Park, Illinois; George Taylor of Arlington, Virginia; and Kenneth Vordenberg of Cincinnati, Ohio—all of the science teaching fraternity; and Dr. Ross MacCardle of the National Cancer Institute; Dr. Israel Light of the U. S. Public Health Service; and Spencer Mapes of the American Cancer Society. Robert H. Carleton, the director of STAR '58, and the author helped, too.

What was the nature of the entries?

Many of the 58 cash award winning entries were concerned with the development of special activities and facilities for gifted and talented students in science. Several entries in this category were accounts of special summer activities, including a precollege science center for boys with motivation and aptitude in science and a summer course in experimental biology. Other entries in this group were a set of laboratory procedures for the gifted girl in physics; a biology laboratory exercise making use of an oscilloscope; several science seminars for the specially talented in the sciences, including one in medical science for tenth-graders; several science project programs for the gifted; and several activities for the gifted in the junior high school, including an introductory course in chemistry and physics.

Several of the cash award winning entries were concerned with the extension of the classroom to the out-of-doors. One of these, from the Northwest, dealt with the school forest; another described an ecological survey of a local park; a third was a comparative ecological study of four different habitants; and a fourth described a field trip to Florida. Ordinarily, this last might not be considered unusual. But the pupils who took *this* trip were from a high school in Connecticut.

Many of the entries pointed up the need for pro-

$250 WINNERS: Left to right across the bottom of these two pages—Alaimo, Cash, Davis, Norris, Orth, Pollack, Roggen, Sailsbury, Sister Mildred Marie, Slesnick.





$500 WINNERS: Left to right—Bassow, Kahn, Perky, Trump, Yarian.

viding secondary school teachers of science with laboratory space, facilities, and assistance for carrying on research and development projects.

One was a mouse smoking device useful in cancer research. This piece of apparatus has already been adopted for experimental use in a state-supported research institution in New York. Another development project consisted of a set of inexpensive three-dimensional models of atoms that can be used to explain the geometry of chemical bonding.

Three of the more unusual winning entries included an account of a science teacher's odyssey of approximately 5400 miles to make a teaching film on uranium; an account of how high school students contributed to a fly control campaign in a large community; and a description of how a raindrop can be used as a basis for a review and integrated unit in mechanics in high school physics.

. The judges noted the absence of any considerable number of entries describing new laboratory exercises in secondary school science. There is a great need, apparently, for more programs such as the one conducted in the summer of 1957 in the biological sciences at Michigan State University. The situation in chemistry will undoubtedly be improved by the series of open-ended experiments being produced by the Manufacturing Chemists' Association, as will the situation in physics through the work of the Physical Science Study Committee, headquartered at the Massachusetts Institute of Technology. More such projects are needed.

Who were the STAR '58 winners?

In the entire awards group of 109 cash award and certificate of merit winners there were 87 men and 22 women.

Twenty-four of the 109 winning entries were submitted by teachers with less than five years of teaching experience; 54 with six to 15 years; 22 with 16 to 25 years; and seven with 26 to 35 years of experience. The average number of years of experience of a winning STAR entrant is ten.

A selection of the winning entries will be published in a brochure which will be distributed to NSTA members in the fall of 1958. Many more of the entries will be published in *The Science Teacher* and in other publications.

STAR '58 winners were announced at the 6th National Convention of the National Science Teachers Association in Denver on March 28, 1958. Medallions and checks were distributed to winners in the cash awards group. Plaques will be distributed to the schools represented by these winners. Certificates of participation will be distributed to all non-winning entrants.

THE $500 AWARD WINNERS

Herbert Bassow, Fieldston School, New York, N. Y.; *Atomic Model Making and the Geometry of Chemical Bonding.*

Paul Kahn, Bronx H. S. of Science, Bronx, N. Y.; *The Assignment: Key to the Biology Laboratory.*

Gregory M. Perky, Newman H. S., New Orleans, La.; *The Physics of a Raindrop.*

Richard F. Trump, Sr. H. S., Ames, Iowa; *The Flies in Our Biology.*

S. Alton Yarian, Emerson Jr. H. S., Lakewood, Ohio; *More Front Seats.*

THE $250 AWARD WINNERS

Angelo C. Alaimo, Kensington H. S., Buffalo, N. Y.; *Will Cancer Be Conquered in the High School Laboratory?*

William W. Cash, Jr., Eagle Rock H. S., Eagle Rock, Va.; *Effective Science Teaching Without Facilities—The Importance of the Use of Public Relations.*

John D. Davis, Exeter H. S., Exeter, N. H.; *A Laboratory Experiment for the Study of Charles' Law.*

Howard E. Norris, The Loomis School, Windsor, Conn.; *Planning and Operation of the Pre-College Science Center at The Loomis School.* (A group entry.)

Concettina T. Orth, Emerson Jr. H. S., Los Angeles, Cal.; *Laboratory Experiences for General Science Taken from a Unit of Work Organized around the Theme "Survival."*

Harvey Pollack, Forest Hills H. S., Forest Hills, N. Y.; *The High School Physics Laboratory Approach.*

Morton S. Roggen, Erasmus Hall H. S., Brooklyn, N. Y.; *A Quantitative Determination of Vitamin C Content in Various Foods.*

Murl B. Sailsbury, Evanston Twp. H. S., Evanston, Ill.; *A Science Seminar for Gifted Secondary School Students.*

Sister Mildred Marie Brenner, Central Catholic H. S., Great Falls, Mont.; *Cancer Education: A Potent Force in Developing Future Scientists.*

Irwin L. Slesnick, University School, Columbus, Ohio; *Room 313—Research Center.*

THE $50 AWARD WINNERS

Norman B. Abraham, Yuba City Union H. S., Yuba City, Cal.; *Creative Chemistry through Student Selected Laboratory Research.*

Bernard L. Alberg, Kaukauna H. S., Kaukauna, Wis.; *Vocational Explorations in Chemistry.*

Arthur J. Baker, Crystal Lake H. S., Crystal Lake, Ill.; *Self-Discovery Activities in the Biological Laboratory.*

Marjorie P. Behringer, Alamo Heights Sr. H. S., San Antonio, Tex.; *Guiding the Talented Science Student.*

Joel Beller, Richmond Hill H. S., Richmond Hill, N. Y.; *The Use of the Oscilloscope in the Biology Laboratory.*

Lois W. Bennett, Mathewson Intermediate School, Wichita, Kan.; *Science Wheel of Motivation—The Junior High Science Curriculum.*

Arnold E. Bereit, West Phoenix H. S., Phoenix, Ariz.; *Chromatography of Inorganic Ions as a Means of Teaching Qualitative Analysis in High School Chemistry.*

Brother Josephus Henlein, Christian Brothers H. S., St. Louis, Mo.; *The Use of Ascaris in High School Embryology.*

John J. Darnaby, Jr., Parkville Jr.-Sr. H. S., Baltimore, Md.; *A System for Accounting, Providing and Maintaining Science Equipment.*

Gerald E. Einem, Melbourne H. S., Melbourne, Fla.; *Science Research.*

Everett M. Ferris, Central H. S., Syracuse, N. Y.; *A Science Seminar for High School Students.*

Harper Follansbee, Phillips Academy, Andover, Mass.; *Grass Seed: Source of Laboratory Material.*

Harold C. Freshwater, Lorain H. S., Lorain, Ohio; *Laboratory Procedures for the Gifted Girl in Physics.*

Robert L. Gantert, Alexander Hamilton Jr. H. S., Seattle, Wash.; *An Introductory Course in Nursing-Medical Techniques.*

Robert S. Gordon, Herricks Jr. H. S., New Hyde Park, N. Y.; *A Group Science Project—Reconstruction of a Field Mouse Skeleton from Owl Pellets.*

Francis F. Grell, Half Hollows Hills H. S., Huntington Station, N. Y.; *You, Bacteria and Three Important Antibiotics.*

Doris E. Hadary, North Bethesda Jr. H. S., Bethesda, Md.; *The World Is Our Textbook.*

Millard Harmon, Weeks Jr. H. S., Newton, Mass.; *Today's Gold—Uranium.*

Thomas M. Haynes, Shortridge H. S., Indianapolis, Ind.; *Life in a Meter Square.*

Dale S. Hunter, Asa Mercer Jr. H. S., Seattle, and **Robert L. Gantert,** Alexander Hamilton Jr. H. S., Seattle, Wash.; *Planting the Seed of Interest.*

David O. Johnston, Franklin H. S., Franklin, Tenn.; *Station to Station Experimentation—Unlimited.*

Catherine H. Kelly, Westside Com. H. S., Omaha, Neb.; *An Introduction to Chromatography in High School Chemistry.*

Ellen L. Littlefield, The Gilbert School, Winsted, Conn.; *Florida Field Trip.*

Anne E. Nesbit, South Jr. H. S., Pittsfield, Mass.; *Ninth-Grade Science Research.*

Robert O. Nunemacher, Roosevelt H. S., Dayton, Ohio; *Group Research Work in High School Chemistry.*

Thomas G. Overmire, Shortridge H. S., Indianapolis, Ind.; *Autumn Coloration of Leaves.*

Stanley C. Pearson, Pasadena City Schools, Pasadena, Cal.; *No Rest for the Gifted.*

Audrey E. Pressler, Frederick H. S., Frederick, Md.; *Bacteria That Make Life Possible.*

James A. Rossas, Oroville Union H. S., Oroville, Cal.; *A Case of and for the Subjective Laboratory.*

Francis J. St. Lawrence, Lakewood Sr. H. S., Long Beach, Cal.; *Science Projects Supplement Laboratory Procedures.*

Richard F. Salinger, Wilton H. S., Wilton, Conn.; *Library Research—A Necessary Adjunct to Laboratory Work.*

David W. Saltus, Wakefield H. S., Arlington, Va.; *Teachers' Manual for a Unit on Non-Euclidean Geometry for the High School.*

Sidney Seltzer, High School Biology Teacher, New York, N. Y.; *Science Experiences in Community Laboratories.*

Sister Mary Cabrini Hohl, St. Mary H. S., Akron, Ohio; *Project Multimeter: An Attempt at Integrating the Teaching Unit on Current Electricity.*

Edgar D. Steckel, Whitehall Twp. Jr.-Sr. H. S., Hokendauqua, Pa.; *A Method for Teaching Elementary Genetics in the Senior High School.*

Charles W. Stonebarger, Brooklyn Friends School, Brooklyn, N. Y.; *Problem Solving in the Physics Lab.*

Kenneth J. Torgerson, Doolen Jr. H. S., Tucson, Ariz.; *Methods for Eighth-Grade Science Teaching.*

David S. Trier, Lincoln H. S., Tacoma, Wash.; *Nature's Laboratory—The School Forest.*

Theodore H. Varbalow, Olney H. S., Philadelphia, Pa.; *Report on the Tacony Creek Park.*

Dorothy L. Vaughn, Neodesha H. S., Neodesha, Kan.; *Stimulating Interest in Science Through Special Projects.*

Gerald L. Witten, Grant Co. Rural H. S., Ulysses, Kan.; *Free Fall Experiment Via Water Drop.*

Dorothy D. Wright, Washington-Wilkes H. S., Washington, Ga.; *How Science Project Work of Gifted Students Is Used to Enrich the Science Program for all Students.*

Harry F. Wunker, Jr., Garfield H. S., Terre Haute, Ind.; *A Study of Antibiotics—For Botany or Biology Classes.*

THE MERIT CERTIFICATE WINNERS

Patricia Archibald, Crown Point H. S., Crown Point, Ind.; *Bean Activities for the Teaching of the Scientific Method in Biology.* **Allen M. Baker,** Hinsdale Twp. H. S., Hinsdale, Ill.; *Chemistry Laboratory Instruction through Use of the Semimicro Technique.* **Sam S. Blanc,** Gove Jr. H. S., Denver, Colo.; *Work Ability of an Insect.* **Brother Cyr,** S.C., McGill Inst., Bayonne, N. J.; *A Physics Practical.* **Paul Bujalski,** Ray H. S., Ray, N. Dak.; *An Apparatus for the Visual Demonstration of Chaotic Molecular Movement, Maxwellian Velocity Distribution, the Heating Effect, and the Gas Laws.*

(Continued on page 168)

$50 WINNERS: Left to right, top row—Abraham, Alberg, Baker, Behringer, Beller, Bennett; second row—Bereit, Brother Josephus Henlein, Darnaby, Einem, Ferris, Follansbee; third row—Freshwater, Gantert, Gordon, Grell, Hadary, Harmon; fourth row—Haynes, Hunter, Johnston, Kelly, Littlefield, Nesbit; fifth row—Nunemacher, Overmire, Pearson, Pressler, Rossas, St. Lawrence; sixth row—Salinger, Saltus, Seltzer, Sister Mary Cabrini, Steckel, Stonebarger; seventh row—Torgerson, Trier, Varbalow, Vaughn, Witten, Wright; bottom—Wunker.

NSTA Activities

Summer Meeting

The theme of this year's NSTA annual summer meeting ties right in with newspaper headlines. Reflecting the current concern with the improvement of science teaching, the theme chosen by the conference committee is "Implications of Research for Science Teaching."

The dates for this year's meeting are June 27 and 28. The place is the campus of The Ohio State University in Columbus.

The featured speakers will include Hugh Odishaw, Executive Director of the U. S. National Committee for the International Geophysical Year; Dr. Glenn O. Blough, Associate Professor of Education at the University of Maryland, College Park, President of NSTA; and Professor Robert Wickware of Willimantic, Connecticut, State Teachers College.

Utilizing resources readily available, the conference will offer opportunities for studying research being carried on under the direction of scientists on the faculty of The Ohio State University. There will also be planning sessions with these scientists to develop ways and means by which a university faculty can contribute to science teaching at pre-college levels. Several field trips to nearby points of interest are also being scheduled as well as discussion groups to consider problems of common concern.

The co-chairmen of the planning committee for the summer meeting are Charles Hoel of Bexley, Ohio, High School and Professor John S. Richardson of The Ohio State University, Retiring President of NSTA. The other members of the committee are: Louis Dunlop, McKeesport, Pennsylvania; Lewis Evans, the University School, The Ohio State University; Mrs. Phyla Humphreys, State Department of Education for Ohio; Professor Donald C. Martin, Department of Physics, Marshall College, Huntington, West Virginia; Charlotte Scofield, Columbus, Ohio; Irwin Slesnick, the University School, The Ohio State University; and Kenneth E. Vordenberg, Supervisor of Science for Secondary Schools, Cincinnati, Ohio, Public Schools.

NSTA Testifies

Capitol Hill—as Congress is frequently referred to by Washingtonians—is, of course, in the forefront of the groups seekings facts on how U. S. education can help increase U. S. output of scientists. Hearings on "Education and Science for National Defense" were held by the U. S. Senate Committee on Labor and Public Welfare from January to March 21 and NSTA was one of the groups asked to testify.

A special statement was prepared jointly by NSTA President Glenn O. Blough and NSTA Executive Secretary Robert H. Carleton and was presented by them before the Senate committee on February 25. Embodying facts and figures that outline the problem and containing recommendations for helping solve it, the statement, titled "Science Teaching in Elementary and Secondary Schools," was reportedly well received. It expressed the belief of the two Association officials that "what we have to say today conforms fully . . . with all statements of views and policies adopted by the NSTA Board of Directors."

In appearing before the committee the two also presented the members with copies of NSTA materials which have proved pertinent and effective. These included: *On the Target! High School Science Teaching and Today's Science-Related Manpower Shortage* (April 1957 *TST*); the article, *Children, Put Away Your Sputniks,* by Dr. Blough (December 1957 *TST*); and the editorial, *Scrutiny, Castigation, and Constructive Support. . . ,* by Mr. Carleton (December 1957 *TST*).

This series of hearings by the Senate committee was held to obtain general information on the science education situation rather than on any specific bills pending for legislative action. Some copies of the Blough-Carleton statement are available and may be obtained on written request from NSTA headquarters.

Chemistry Test

The High School Chemistry Test, Form N, has gone through a second printing. This is the achievement test, first published about a year ago, which was developed by a subcommittee of 42 teachers appointed jointly by NSTA and the Examinations Committee of the Division of Chemical Education of the American Chemical Society. Elbert C. Weaver, of Phillips Academy, Andover, Massachusetts (now on leave with the Manufacturing Chemists' Association, Washington, D.C.), served as chairman of the subcommittee. (For a report on the test, see *Norms of the High School Chemistry Test, Form N,* February 1958 *TST,* pages 32-34.)

Copies of the test are available to secondary school science teachers if requested in writing on official school stationery through official school channels. Write to: Theodore A. Ashford, ACS Examinations Committee Chairman, St. Louis University, St. Louis 4, Missouri.

FSA Activities

"In the Hand of Youth . . ."

An attractive new booklet has just been mailed to more than 1000 key persons in business-industry who have concern in the development of future scientists. Titled "In the Hand of Youth . . . Destiny in Science," the booklet reports on what the Future Scientists of America Foundation is, how it operates, and its recent accomplishments and plans. Designed to stimulate business-industry interest in and financial contributions to FSAF, the booklet delineates the Foundation's unique and important mission. The scope of FSAF activities presented by word and picture underscores the statement in the introduction that the "Foundation's effectiveness . . . and its success in dealing with a critical national problem, depend on help from American business and industry."

Although general distribution is not being made to NSTA members, copies of the booklet are available to science teachers who can use it with business-industry contacts in their own localities on behalf of FSAF. Requests for copies—only as many as can be put to practical use, please—should be sent to: FSAF, 1201 Sixteenth Street, N.W., Washington 6, D.C.

It is too soon, of course, to judge what the response to the booklet will be. In the meantime, contributions are being recorded for the 1958 FSAF roster of sponsors. As of mid-February, $17,000 had been received for both general and special programs. The 1958 sponsors as of that date are:

Crown Zellerbach Foundation
The Johnson Foundation
Kennecott Copper Corporation
Western Electric Company

Research Assistantships

Received too late for the listing of FSAF-compiled Summer Research Assistantships for Science Teachers in the March issue of *TST* (pp. 86 and 87) was notice of an additional offering at the *University of Rochester*. Its Department of Physics and Astronomy reports *at least one* research assistantship for two months for a high school science teacher "with appropriate skills. . . The most useful kind of person would be someone with some background or skill in electronics." The man to contact is Professor Morton F. Kaplon, Department of Physics and Astronomy, College of Arts and Science, University of Rochester, Rochester 20, New York.

Military Service

FSAF has been advised by the Scientific Manpower Commission that "there is no excuse at the present time for the (military) induction of essential teachers." The statement came from Dr. Howard A. Meyerhoff, the Commission's executive director, whom FSAF consulted after receiving a number of inquiries from science teachers on their military service responsibilities. Recognizing the importance of the teacher in developing future scientists, FSAF undertook the check on the science teacher's military service status.

In writing his opinion, Dr. Meyerhoff enclosed for guidance a copy of his answer to a school official's letter which FSAF had transmitted to him. He answered:

> "The Scientific Manpower Commission is handling problems of the kind that are troubling you, and we will be glad to assist in any individual cases that may arise in your school system.
>
> "Qualified science and mathematics teachers are considered to have a 'critical occupation,' and high school teaching is classified as an 'essential activity.' Under Selective Service rules and regulations, this set of facts qualifies any of your teachers who are spending the greater part of their time on science and/or mathematics instruction for occupational deferment (Class II-A). Of course, it does not relieve them of their obligation to serve in uniform, but it also gives them the option of fulfilling their military obligation by entering the Critical Skills Reserve Program. This program requires only three months of military training, and it is sometimes possible to arrange the period of service so that it will coincide with the summer vacation. Unfortunately the several branches of the armed services limit the number of people they will accept in the Critical Skills Reserve Program, and in view of this situation, the Selective Service System has ruled that people who are eligible but who cannot be accepted may have their induction postponed, but the local boards are strongly urged to place such people in Class II-A, at least until the Critical Skills Reserve Program can accommodate larger numbers.
>
> "In dealing with local boards on specific cases of teachers in your school system, may I suggest that any I-A classification given them be promptly appealed and further, that in any negotiations with local boards with regard to individual cases, you refer them to Selective Service Operations Bulletin No. 184, issued under date of October 10, 1957. If any board should be recalcitrant in the face of this operations bulletin, or if any state appeal board should uphold a I-A classification given by a local board, may I urge that you refer the case to the Scientific Manpower Commission (1507 M Street, N.W., Washington 5, D.C.), and we will ask Selective Service headquarters to handle it."

VAN EVERA . . . from page 126

atom, molecule, ion, solution, and the difference between a *compound* and a *mixture,* if anything we say about physical science is to have any real meaning. Anyone who has read any of the writings of the alchemists must be impressed with the confused terms they used. Their statements and definitions were not clear (whatever the reason). It was because of this confused writing and poor definitions that so many alchemists failed to understand each other.

Our definition of the word compound, for example, must be so clear that it excludes at the same time both elements and mixtures. Thus, if we have defined a substance as being a kind of matter, the properties of which are fixed and whose composition from sample to sample does not vary, and if we define an element as being a substance whose atoms have the same atomic number, then we can very easily define a compound as being a substance containing atoms having two different atomic numbers.

Note in this definition of the word compound that we are presupposing a knowledge of two other definitions, that of atomic number and that of the term substance. In this definition of the word compound, I say that it is a substance, which automatically means that its composition does not vary from sample to sample. If I say that it has atoms of more than one atomic number, that means that there are at least two different kinds of atoms in it. No upper limit is set because no upper limit is known other than the number of kinds of atoms. If a student does not have clearly in his mind the difference between an atom and a molecule, or between a compound and a mixture, he is never going to get anywhere in chemistry.

Once we have given these fundamental definitions, we must be true to them in our subsequent teaching. Moreover, if as we go along in our teaching, we find that our concepts so change that one of our original definitions is no longer acceptable, then we must very carefully, with an eye to the student, change that definition. This means that we must explain why we originally gave him a definition which proved to be inadequate. One can always point out how the new definition expands or otherwise changes the original one, and so use this change as a teaching tool to demonstrate the growth of science and how concepts change as our total knowledge increases.

Just recently I was reading a new textbook that had many very admirable qualities about it. One of the things about it that I do not like and which

will make me vote against its use is that after discussing compounds very carefully and defining them as having a constant composition, the author subsequently in discussing the compounds of hydrogen listed as compounds those mixtures which hydrogen forms with the platinum metals. He calls these mixtures compounds and says that their composition varies, which in my opinion is very poor science and even worse pedagogy. Our definitions must be clear and they must be used with utmost honesty.

Not only must these fundamental definitions be true, not only must these fundamental definitions be succinct and carefully thought out, not only must they be used consistently throughout the course of instruction, but ideally they should always represent the latest thinking. A few paragraphs back, I defined an element as being a substance all of whose atoms have the same atomic number. When I had my first introduction to chemistry in 1919, we defined an element as being a kind of matter, all of whose atoms were exactly alike. Isotopes had not been discovered at that time. Henry Moseley had done his pioneering work on atomic numbers only five years before and so it was discussed, if at all, only in graduate courses.

Our concept of an element in those days was much different than it is now. That freshman textbook of mine had in it not a single word about atomic structure. Even in the discussion of atoms there was no indication that an atom had any structure, and I came out of that course with a distinct feeling that an atom of copper was copper all the way through. Many students and some adults complain because definitions must be changed. I have had parents complain to me bitterly that the definitions I was giving their youngsters in general chemistry were different from the ones that they had had.

Changes of this nature must take place in any living, growing science. There probably have been no changes in Latin grammar in the last 1000 years, which is why it is called a dead language. Chemistry, fortunately, is not a dead science, and as it grows our concepts must change. Here, again, we must be careful to remember that it is only the concepts that change, not the facts. Copper sulfate was doubtless blue in the days of ancient Egypt and it is blue today. The Egyptians had no concept that it was composed of ions, and, indeed, neither did a chemist of 1850. So while we define our concepts as accurately as possible, we must always realize and make our students realize that these are the concepts of the moment, historically speaking, and that they will certainly be changed as research turns up more facts.

A good set of fundamental definitions will help the student to an understanding of how concepts develop. For example, let us discuss the definition of the meter. There is only one proper definition of the meter at present and it is: The meter is a length equal to the distance between two particular marks on a platinum iridium bar which is kept at the International Bureau of Standards in Sevres, France. Just that. The difference between two scratches on a bar. But that alone will not satisfy. The teacher then must explain how the distance between those two lines was first determined, and show how we need in any unit of measurement some standard by which we can compare our everyday working tools. Since it is inconvenient for the individual scientist to compare his meter stick with the earth's quadrant, of which the meter is supposed to be the ten-millionth part, it was necessary that scientists do the job once and for all, and the bar with the scratches on it is the result.

One can also point out that scientists are attempting to define the meter in terms of some other easily reproduced quantity which does not vary—such as the wave length of the red line emitted by cadmium in the hope that a means may be found to more easily reproduce an accurate meter in one's own laboratory. This will be a scientific advance, indeed.

The task of teaching chemistry is not an easy one. Our students come to us accustomed to generalities and "the broad view;" as teachers of chemistry we have to make them like the specific and the detailed view. This involves changing their way of thinking in a radical fashion. One way of doing this is to require careful definition of all terms from the beginning. This is not easy, for even the young people do not find it easy to change their habits of thought. But they can be shown that there is beauty in precision, satisfaction in the conquest of a new method of approach, and truth in detail.

McKIBBEN . . . from page 139

freeing the teacher to spend more time with students.

An area in which we may be able to learn from British science teaching is in the type of laboratory activity provided. In the United States, there is general agreement that an understanding of important principles of science such as "All organisms depend directly or indirectly upon the sun for their food" and "Energy cannot be created or destroyed, but merely changed from one form to another" is a major objective of science education. Some laboratory activities are obviously of greater value than others in teaching these principles. British textbooks and laboratory manuals contain a wealth of ingenious experiments not found in similar American sources. We might do well to look into these British sources and evaluate them for our own use.

Course Organization and Content

In grammar and public schools large enough to have more than one class per form in a subject there was usually an examination course and one or more of a practical, less academic nature for those not preparing for the G.C.E. in that field. The content of the examination courses is obviously set by the examinations; of the others, less by the restrictions of the particular science than by what is thought to be useful to the student. These "streams," as they are called, offer the same psychological advantages and disadvantages as homogenous grouping arrangements in this country.

The schedules of the science courses in the schools visited varied considerably with regard to the level at which the subject was begun and to the number of classes per week. In a majority of these schools biology was started in the first form and chemistry and physics as such in the third form. Frequently there were courses in general science in the lower forms. If a student planned to take the G.C.E. examinations in a specific field, he would continue to take this subject through the sixth form, otherwise he would drop it in favor of other subjects. The number of class periods per week in a science invariably increased from one or two in the lower forms to as many as ten in the upper forms.

There are certain psychological advantages in the British type of schedule. If a science is offered in several forms, certain concepts may be taught at more appropriate age levels than they are in our

high schools or their understanding may be extended over a period of several years with the increasing maturity of the student. With biology, chemistry, and physics as such being taught at lower levels than in the United States, two or more sciences may be studied concurrently over a period of years. This makes possible greater transfer from one science to another.

There are signs in the United States that our science courses for average and above average students are becoming more academic than they have been since the early part of the century. This may be seen in the new accelerated science courses being developed in increasing numbers in secondary schools participating in the school and college program for admission with advanced standing. It may also be seen in the appearance of more and more subject-matter centered textbooks and in their increasing popularity among teachers in both the physical and biological sciences.

With the increasing interest in Great Britain in the scientific method on one hand and on the other hand the greater emphasis in the United States on factual information, there is evidence that our two countries, whether consciously or unconsciously, are coming into closer agreement about the training of scientists.

HOLLMEYER . . . from page 129

The automobiles we have today are the result of change, a desire on the part of someone to make a change who believed a change would be an improvement and was willing to do those things which were necessary to complete the change. Obviously this meant convincing others (altering ideas, attitudes, prejudices, etc.) that the change was worthwhile; that appropriations were needed for new buildings and equipment; that certain actions were necessary such as the discarding of buildings and equipment which would no longer be usable and increasing or decreasing the number of people employed and adjusting their working hours. The science programs of the 20's, the 30's, and the 40's are no more acceptable in 1958 than some of the automobiles of those days.

Are the criticisms of the science program justified? Are these criticisms "signal lights" which should be of some concern to teachers, administrators, board members, and parents? Might there be something lacking in our science program? Who were the scientists comparable to Pasteur or Koch that our American educational program produced in the 19th century? Who *will be* America's great scientists of the 20th century?

Why is continuous change necessary in our science program? If we can believe that our educational program should help children develop into worthy members of our society, then it follows or at least is implied that the program should be geared or planned to meet this objective, and those who have the responsibility for planning the program should have an understanding of and be familiar with the many facets of our society. One of the decisions which the planners must make is how valuable or important science experiences are in the lives of people; another is how to give them sufficient emphasis in the educational program. There are people who believe that science experiences serve two purposes: (1) Worthwhile experiences in this area help children understand and use wisely the achievements of scientists, engineers, and technicians. (2) Such experiences will help keep our society in the forefront in scientific and technological developments by training an adequate number of scientists, engineers, and technicians.

Continued changes in our society call for changes in our educational program if we are to meet the objectives mentioned above. With the rapid scientific developments during the past few years in communication, transportation, and power, it follows that there need to be changes in our science program if our young people are to know and understand these new developments and how they will affect their living. How old does a child need to be before he can recognize the pleasure in riding in an automobile or an airplane? How old does he need to be before he can understand that television is an improvement over radio? How old does he need to be before he is interested in space ships?

Mike at 20 months of age is interested in turning on and off the electric fan, adjusting the television, pulling out the dresser drawers to see what is inside. When will he be old enough to develop an interest in science? To find information about science which will help him to live more satisfactorily? To use his power of observation to gain further knowledge? When Mike reaches the age of 21, will he buy transportation to and from the moon? Will he while there buy or lease property and erect a motel and filling station? These are challenges to our professional educators.

If you are a parent, teacher, or administrator interested in the welfare of children, I suggest that you accept the challenge and "look and see" if there is not something about your present science program which can be improved; and then contribute your efforts in making the improvement. Science can be interesting, exciting, and thrilling to the imagination, but only as interesting, exciting and thrilling as the people who are responsible for the program wish to make it.

Book Reviews

SCIENCE FOR THE ELEMENTARY SCHOOL TEACHER. Gerald S. Craig. 894p. $6.75. Ginn and Company, Boston. New edition, 1958.

Gerald Craig might well be honored by the title "Grandfather of Elementary School Science" after being known as the "Father" for many years. He has seen his concept of science grow and mature until now the entire nation is aware of it and clamoring for it in the earliest years of children's education.

In a full rich life Dr. Craig has taught students, teachers, and teachers of teachers what good science education for the young child should be. It is good to see that he remains active in person and in writing though he has now reached the Professor Emeritus status when many men would sit back and rest on their laurels.

The original edition of *Science for the Elementary School Teacher* appeared about 20 years ago and became a bible in its field for classroom teachers. For years it was the only professional book of its kind until a generation of educators finally grew up and produced others which were rooted in the soil prepared by Craig. It was a source of sincere regret to many to see the famous Craig book grow older and older even though its contents remained as sound as ever.

Now the new edition appears as a culmination of a lifetime of work in a field which promises to attain stature equal to all the other curriculum areas essential in the general education of young people. There are few teachers anywhere who question any longer that science belongs in the elementary school curriculum from kindergarten upward. But there are still thousands of teachers who fear to teach it. We still have not reached the time when all teachers are properly prepared for this essential responsibility. Neither do all administrators know enough about it to offer enlightened leadership.

Science for the Elementary School Teacher is the answer to all these and for all others who want a book which interprets purpose and then offers solid, practical content and methods for putting science purposes into practice. The book is organized into five sections. The first, Science and the Elementary School, places the subject in its proper setting as an essential part of child education in our American democracy. The next three parts comprise the bulk of the book and consist of comprehensive yet concise content in all the science subject areas needed in the elementary school. Factual information and suggestions for guiding children's experiences are offered for the full range of content needed to understand THE EARTH, UNIVERSE, LIFE ON EARTH, and ENERGY OF THE UNIVERSE. Basic concepts are presented in bold type.

Factual data needed for understanding the concept follows. Experiences to make the learning meaningful follow this. Together the trio make up complete packages for scores of essential understandings which the elementary school child needs to develop. All this is developed in a manner which helps to avoid mere, unapplied memorization of facts.

Obviously no single book can be really complete. Yet this book with nearly 900 pages comes as close as one volume could. This reviewer regrets that so little is done with the currently fascinating topic of space travel. Astronomy needs to be space travel-centered these days yet only two illustrations suggest this, one of the solar system with space travel times indicated; another of the layers of the atmosphere showing a satellite in the ionosphere. There is no text explanation. But, as has been said, no book can have everything.

The last part of the book deals with scope, continuity, and evaluation of science. Craig presents the scope and sequence for a kindergarten through eighth-grade science program year by year coupled with a warning for caution in the way teachers use such a classification. In the light of present lack of agreement nationally and even locally on the matter of content placement, Craig's list deserves careful study. Its use must be governed by the basic values he stresses throughout the book.

A very complete, up-to-date bibliography at the end of the book serves as a valuable guide for more intensive reading keyed to each of the topics presented.

This book deserves to be on the desk of every elementary school teacher. A Glencoe associate after looking through it for an hour commented, "This appears to me as one of the best teacher references for both information and technique. Best of all it offers encouragement to teach science because the teacher can understand it."

JOHN STERNIG
Assistant Superintendent
Glencoe, Illinois, Public Schools

THE WHY OF PHYSICS PROBLEMS. Fred B. Eiseman, Jr. 455p. $5. Fred B. Eiseman, Jr., John Burroughs School, 755 South Price Road, St. Louis 24, Missouri. 1957.

Offset-type publication, with diagrams and charts, developed by the author, chairman of his school's science department, for use as a supplement to the regular text in his own teaching. Its comprehensive, detailed facts, formulas, explanations, and problems and solutions—all designed to bring understanding of *why* physics problems are solved as they are—make the book virtually a text in itself. Hardcover book, published by the author, available only from him at address above.

GALILEO AND THE MAGIC NUMBERS. Sidney Rosen. 212p. $3.50. Little, Brown and Company, Boston. 1958.

The life of the great pioneer scientist—his brilliant work, his friends, the persecution he suffered for his revolutionary researches and concepts—told skillfully and colorfully in narrative style. Written for a youthful audience, the book should fascinate as well as impart valuable historical knowledge to young science students. Effective literary medium for explaining why scientists so long fought upstream.

Audio-Visual REVIEWS

THE LADYBIRD STORY. 11 min. 1957. Color. Pat Dowling Pictures, 1056 South Robertson Blvd., Los Angeles 35, Calif.

Recommendation: Upper elementary, junior high school general science, and high school biology areas.

Content: Shows the cottony-cushion scale, its anatomy, habits, and damage done by it particularly to fruit trees. The serious condition existing in the citrus groves is clearly pointed out, as is the work of Albert Koebele in discovering and importing the ladybird beetle from Australia to control the scale. The method of attack on the scale and the ladybird's life cycle are very well presented. The film vividly and effectively explains the value of the ladybird beetle to man.

Evaluation: Photography and commentary very well done. The film presents valuable, factual information in a most pleasing way. The film guide is helpful.

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MEIOSIS. 10 min. Color. International Film Bureau, 57 East Jackson Blvd., Chicago 4, Ill.

Recommendation: Senior high school advanced biology and college biology and genetics areas.

Content: Deals with the first two chromosome divisions in the process of gamete formation. Shows all stages by diagrammatic means. Formation of chromosomes is followed by the first and second divisions, then crossing over and formation of chromatids. The migration of chromosomes to opposite poles of the cells is followed by migration of chromatids to new poles of the daughter cells. The end result is the formation of four haploid daughter cells from the original mother cell.

Evaluation: Very factual in nature, the film is well organized but rapid in pace. Obviously it is designed for able students. An Australian film, it may present some difficulty because of the accent of the commentator. A second showing is recommended for this highly informative film.

◊ ◊ ◊

EARTHWORMS. 11 min. 1957. Color. Pat Dowling Pictures, 1056 South Robertson Blvd., Los Angeles 35, Calif.

Recommendation: Intermediate science, junior and senior high school general science and biology areas.

Content: Contains a wealth of valuable, little known information about a little known animal. The film shows how earthworms eat, "hear," tunnel, and live. The simple digestive tract is nicely explained. It is pointed out that the earthworm is only one—but an important one—of a number of factors involved in soil improvement.

Evaluation: Very good photography and sound. Color adds a great deal to the presentation. While aimed at upper elementary levels, the film contains much of interest to more advanced students. Guide is included.

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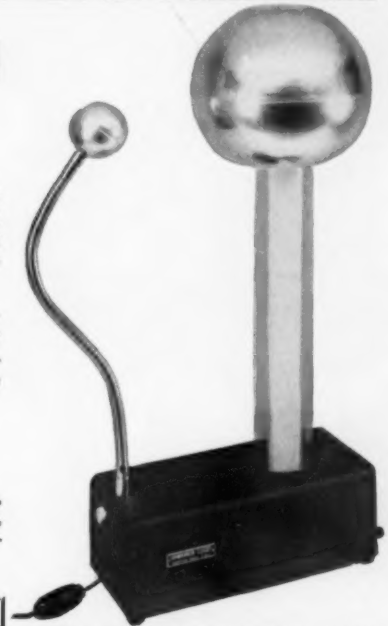

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